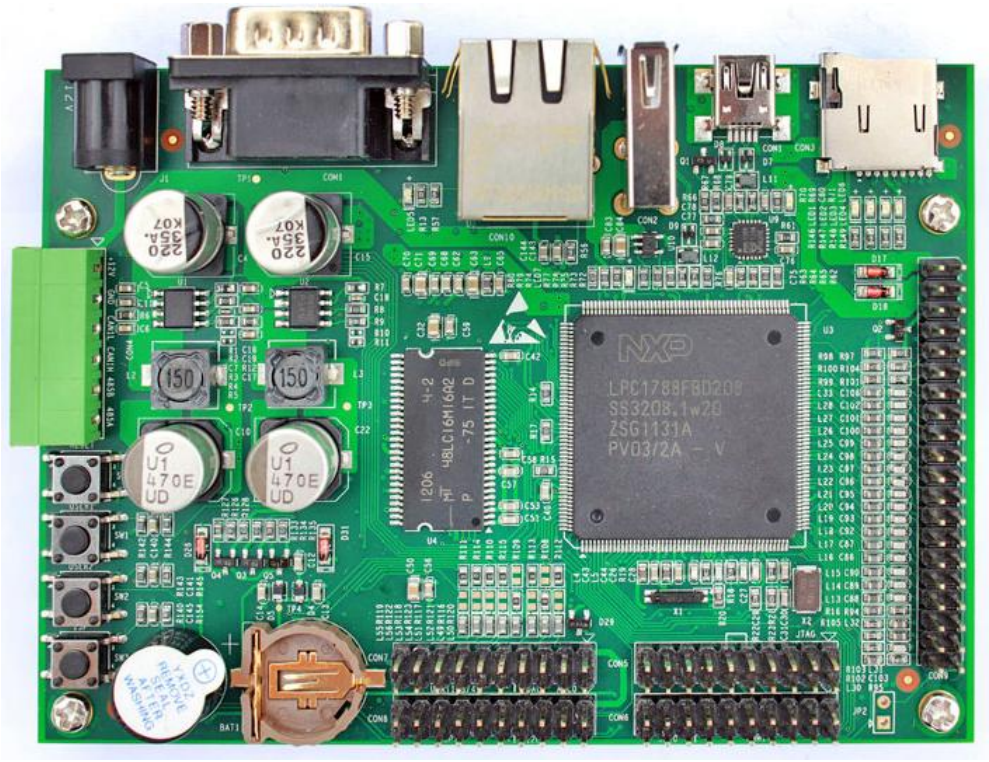
SBC1788 User Manual

Release: 2012-08-06

SBC1788 Single Board Computer

- *120MHz LPC1788FBD208 NXP 32-bit ARM Cortex-M3 Microcontroller*
- *CPU Internal 512KB of Flash, 96KB of SRAM and 4KB of EEPROM*
- *Onboard 128MB Nand Flash, 32MB SDRAM*
- *USB2.0 Host Full-speed Port and 1 USB2.0 OTG Full-speed Port*
- *UARTs, RS485, Ethernet, CAN2.0B, LCD & Touchscreen, TF, Buzzer…*
- *Supports uC/OS Ⅱ_v2.86 & uC/GUI_v3.90a*
- *Supports FatFs_vR0.08a File System*
- *Supports LwIP_v1.4.0 Protocol Stack*



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Version of update records:

Rev	Date	Description
V1.0	2012-8-06	Initial version
V1.1	2012-11-29	Removed “If 7 inch LCD be used, make sure that jumper JP1 is fitted.” in *4.1.1 LCD_Display*,*4.1.2 LCD_Touch*,*4.18 SSP*,*5.1 SBC1788-emWin512*,and *5.3 SBC1788-uCOSII-uCGUI.*

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Charter 1 Overview

1.1 Product introduction

Embest SBC1788 Single Board Computer is an compact industrial controller board based on NXP's LPC1788FBD208 ARM Cortex-M3 microcontroller which is running on up to 120MHz with 512KB of internal Flash memory, 96KB of internal SRAM, 4KB of internal EEPROM, a 10/100 Ethernet Media Access Controller (MAC), a USB full speed device/host/OTG controller, four UARTs, two CAN channels and a collection of serial communications interfaces.

The SBC1788 board also has external 128MB Nand Flash and 32MB SDRAM. It takes full features of the LPC1788 microcontroller and has exposed many hardware features through headers or connectors including UARTs, USB, Ethernet, CAN, LCD, I2C, SPI, PWM, ADC and DAC to meet various applications.

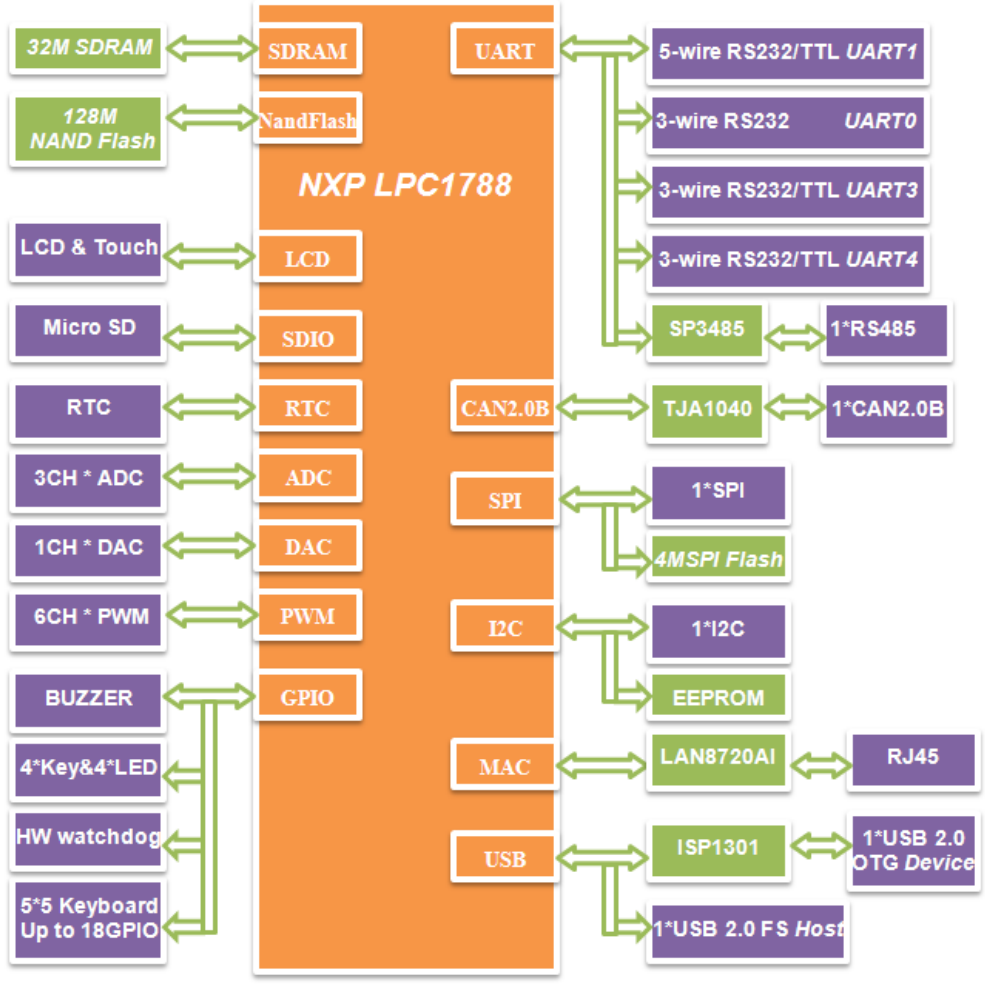
Embest has ported uC/OS-II to support their Cortex-M3 SBC1788 board and the software also features the GUI support on uC/OS-II and LwIP_v1.4.0 protocol support. Embest provides the uC/OS-II BSP and plenty of software examples, board schematic and user manual to help customer better understanding this board and develop your own applications.

Note: You are required to purchase a license for using uC/OS-II and uC/GUI in any commercial application

SBC1788 can be used in the following applications:

- Industrial Control
- Medical Equipment
- Home Automation
- Human Interface
- Consumer Electronics
- Test and Measurement

SBC1788 Function Block Diagram



LEGEND

CPU internal module

Onboard IC or reserved chip

Onboard Interfaces or Connectors

1.2 Feature

The LPC1788 is a Cortex-M3 microcontroller for embedded applications featuring a high level of integration and low power consumption at frequencies of 120 MHz Features include 512 KB of flash memory, 96 KB of data memory, Ethernet, USB 2.0 Host/OTG/ Device, 8-channel DMA controller, 5 UARTs, 2 CAN channels, 3 SSP/SPI, 3 I2C, I2S, 8-channel 12-bit ADC, 10-bit DAC, QEI, LCD controller, SD/MMC interface, motor control PWM, 4 general purpose timers, 6-output general purpose PWM, ultra-low power Real-Time Clock with separate battery supply, and up to 165 general purpose I/O pins.

The SBC1788 Single Board Computer exposes many of these features to the user in support of developing specific solutions. This board is characterized as follows:

- **Processor**
  - NXP LPC1788FBD208 Microcontroller
  - ARM 32-bit Cortex-M3 CPU, frequency up to 120MHz
  - On chip 512KBytes Flash，96KBytes SRAM，4KBytes EEPROM
  - Flexible static memory controller that supports Compact Flash, SRAM, PSRAM, Nor and Nand memories
  - LCD controller, supporting up to 24-bit true color mode and 1024*768 pixels resolution
  - USB 2.0 FS Device/Host/OTG
  - 10/100 Ethernet MAC with MII/RMII interface and associated DMA controller
  - 2 CAN 2.0B interfaces, 5 USARTs and 1 I2S, 3 I2C and 3 SSP
  - 4 x 32-bit timers, 2 x standard PWM and 1 motor control PWM with support for
  - Three-phase motor control
  - 1 x 12-bit A/D converter, 1 x 10-bit D/A converter
  - Up to 165 general purpose I/O pins
- **External Memory and Storage**
  - 128Mbytes Nand Flash
  - 32Mbytes SDRAM
  - 4MBytes SPI Flash and 2kBytes EEPROM (Reserved for soldering)

- Micro SD card slot

■ **LCD/Touch Screen**

- 4.3 inch (480 x 272-pixel RGB resolution) and 7 inch (800 x 480-pixel RGB resolution) TFT color LCDs for selections
- 4-wire resistive touch screen
- 16-bit RGB565 color format

■ **Data Transfer Interfaces**

- 1-channel 3-wire RS232 Serial Port (UART0, DB9)
- 1-channel 5-wire Serial port, TTL voltage (UART1, RS232 is designable)
- 1-channel 3-wire RS232 Serial port (UART3, TTL is designable)
- 1-channel 3-wire Serial port, TTL voltage (UART4, RS232 is designable)
- 1-channel RS485 Serial port (brought out by Phoenix Connector)
- 1 x USB2.0 Host, Full-speed, 12Mbps
- 1 x USB2.0 OTG/Device/Host, Full-speed, 12Mbps
- 10/100 Ethernet interface
- 1 x CAN2.0B interface

■ **Input Interface and Other Facilities**

- 2 x USER buttons
- 1 x RESET button
- 1 x ISP button
- 20-pin standard JTAG interface
- 1 x Buzzer
- RTC battery socket (User needs to prepare battery, CR1220 model is recommended)
- Windowed watchdog timer (WWDT)
- Supports onboard watchdog reset through hardware (reserved function)
- 1 x LED for Power indicator
- 1 x LED for USB Host FS indicator
- 1 x LED for USB OTG FS indicator

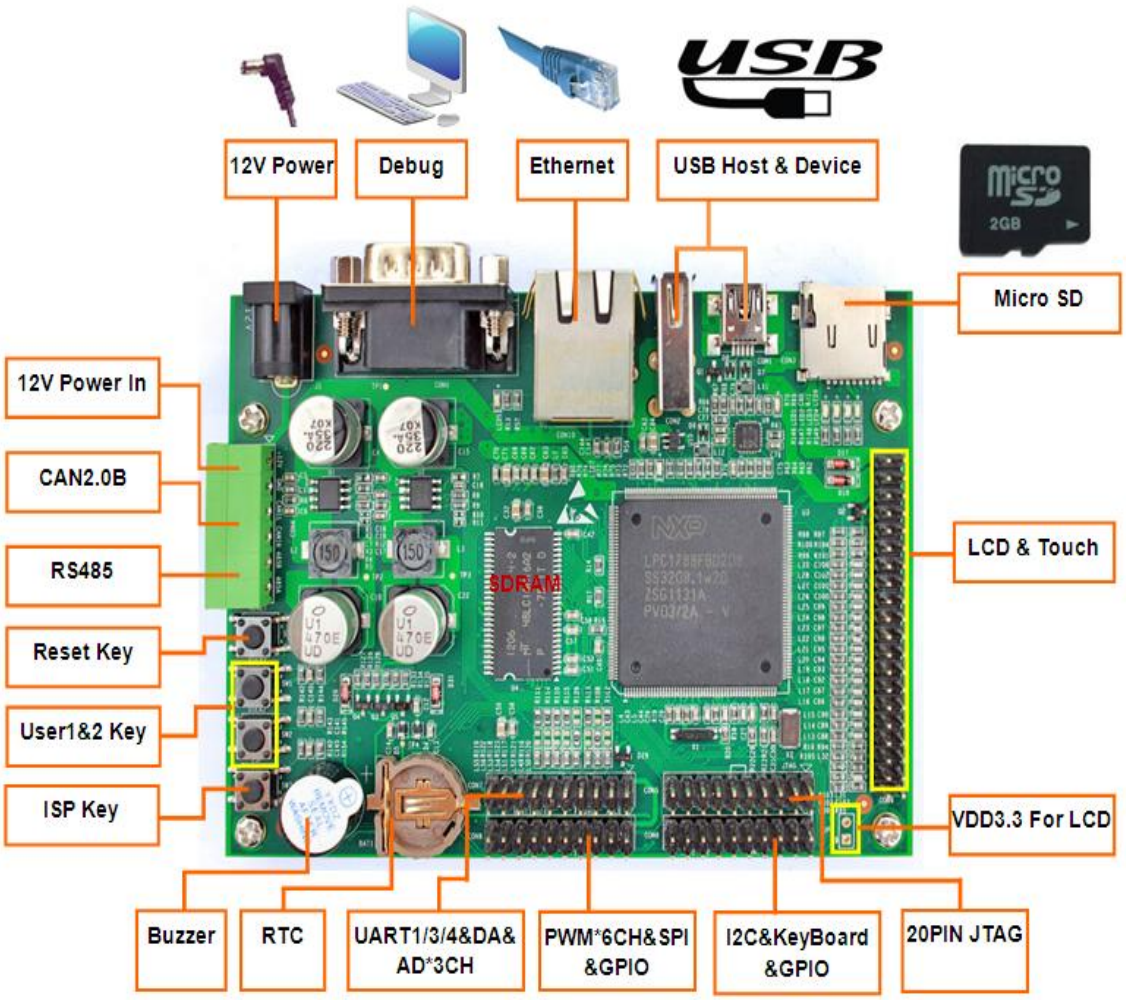
- 4 x User LEDs
- 3 x Extension Interfaces (2.54mm pitch 2*10-pin connector)
  - Up to 18 independent GPIO pins are all brought out
  - 5*5 matrix keypad interface
  - channel general purpose PWM with 6 outputs
  - One 3-channel ADC
  - One DAC
  - One SPI
  - One I2C

- **Mechanical Parameters**
  - Dimensions: 120 mm x 87 mm (6-layer PCB design)
  - Power consumption: 120mA@12V (working without LCD)
  - Working Temp.: -40 ℃ ~ 85 ℃
  - Humidity Range: 0% ~ 90

Charter 2 Hardware sysytem

2.1 Hardware Interface Diagram

The hardware interface diagram of SBC1788:



2.2 Hardware Interface

2.2.1 Power Input Jack

Table 2-1 Power Input Jack

J1		
Pin	**Signal**	**Description**
1	+12V	Power supply(+12V) 1.25A (Type)

2	GND	GND
3	GND	GND

2.2.2 Serial Port

Table 2-2 Serial Port Interface

COM1		
Pin	**Signal**	**Description**
1	NC	NC
2	RXD	Receive data
3	TXD	Transit data
4	NC	NC
5	GND	GND
6	NC	NC
7	NC	NC
8	NC	NC
9	NC	NC

2.2.3 Ethernet Interface

Table 2-3 Ethernet Interface

CON10		
Pin	**Signal**	**Description**
1	TX+	TX+ output
2	TX-	TX- output
3	RX+	RX+ input
4	CT	CT
5	CT	CT
6	RX-	RX- input
7	NC	NC
8	SHIELD	Shield

9	LED1	LINK LED
10	VDD3V3	3.3V Power for LED
11	LED2	SPEED LED
12	VDD3V3	3.3V Power for LED
13	4&5	Connect to shield
14	7&8	Connect to shield
15	NC	NC
16	NC	NC

2.2.4 USB Host Connector

Table 2-4 USB Host connector

CON2		
Pin	**Signal**	**Description**
1	VBUS	+5V
2	D-	USB Data-
3	D+	USB Data+
4	GND	GND

2.2.5 USB Device Connector

Table 2-5 USB Device Connector

CON1		
Pin	**Signal**	**Description**
1	VBUS	+5V
2	D-	USB Data-
3	D+	USB Data+
4	ID	USB ID
5	GND	GND

2.2.6 MicroSD Card Interface

Table 2-6 MicroSD Card Interface

CON3		
Pin	**Signal**	**Description**
1	DAT2	Card data 2
2	DAT3	Card data 3
3	CMD	Command Signal
4	VDD	VDD
5	CLK	Clock
6	VSS	VSS
7	DAT0	Card data 0
8	DAT1	Card data 1
9	CD	Card detect

2.2.7 LCD Interface

Table 2-7 LCD Interface

CON9		
Pin	**Signal**	**Description**
1	GND	GND
2	DCLK	DCLK
3	HSYNC	HSYNC
4	VSYNC	VSYNC
5	GND	GND
6	RST	RST(Reserved)
7	R3	Red data input
8	R4	Red data input
9	R5	Red data input
10	R6	Red data input

11	R7	Red data input
12	GND	GND
13	G2	Green data input
14	G3	Green data input
15	G4	Green data input
16	G5	Green data input
17	G6	Green data input
18	G7	Green data input
19	GND	GND
20	GPIO_0	GPIO(Reserved)
21	B3	Blue data input
22	B4	Blue data input
23	B5	Blue data input
24	B6	Blue data input
25	B7	Blue data input
26	GND	GND
27	DEN	Display enable
28	VDD3V3	+3.3V power supply
29	VDD3V3	+3.3V power supply
30	GPIO_1	I2C_SCL(Reserved)
31	GPIO_2	I2C_SDA(Reserved)
32	Y+	Terminal of touch panel
33	X-	Terminal of touch panel
34	Y-	Terminal of touch panel
35	X+	Terminal of touch panel
36	PWREN	LCD power enable
37	VDD5V	+5V power supply
38	PWM	LED Dimming Control by PWM Signal
39	VDD5V	+5V power supply

40	VDD12V	+12V power supply

2.2.8 JTAG Interface

Table 2-8 JTAG Interface

CON5		
Pin	**Signal**	**Description**
1	VTREF	+3.3V power supply
2	VSUPPLY	+3.3V power supply
3	NTRST	Test system reset
4	GND	GND
5	TDI	Test data input
6	GND	GND
7	TMS	Test mode select
8	GND	GND
9	TCK	Test clock
10	GND	GND
11	RTCK	GND
12	GND	GND
13	TDO	Test data output
14	GND	GND
15	NSRST	Test system reset
16	GND	GND
17	DBGRQ	Connect to GND
18	GND	GND
19	DBGACK	Connect to GND
20	GND	GND

Note: *Connect JTAG tool (ULink, JLink etc.) to SBC1788 JTAG interface CON5 through IDC20 cable. Red line onside indicates the first pin of IDC20 cable. Triangle onside indicates the first pin of JTAG interface.*

2.2.9 PWM&SPI Interface

Table 2-9 PWM & SPI Interface

CON6		
Pin	**Signal**	**Description**
1	VDD3V3	+3.3V power supply
2	GND	GND
3	P3_19	P3[19]
4	PWM1_1	PWM1[1]
5	P3_20	P3[20]
6	PWM1_2	PWM1[2]
7	P3_21	P3[21]
8	PWM1_3	PWM1[3]
9	P3_22	P3[22]
10	PWM1_4	PWM1[4]
11	P3_23	P3[23]
12	PWM1_5	PWM1[5]
13	GND	GND
14	PWM1_6	PWM1[6]
15	SPI0_SCK	SPI0_SCK
16	SPI0_SSEL	SPI0_SSEL
17	SPI0_MOSI	SPI0_MOSI
18	SPI0_MISO	SPI0_MISO
19	GND	GND
20	VDD5V	+5V power supply

2.2.10 UART&ADC/DAC Interface

Table 2-10 UART&ADC/DAC Interface

CON7		
Pin	**Signal**	**Description**
1	VDD3V3	+3.3V power supply
2	GND	GND
3	ADC0_IN0	ADC0_IN0
4	ADC0_IN2	ADC0_IN2
5	ADC0_IN1	ADC0_IN0
6	DAC_OUT	DAC_OUT
7	P1_05	P1[5]
8	GND	GND
9	TXD3	UART3_ TXD
10	TXD1	UART1_ TXD
11	RXD3	UART3_ RXD
12	RXD1	UART1_ RXD
13	P1_13	P1[13]
14	P0_14	P0[14]
15	TXD4	UART4_ TXD
16	CTS1	UART1_CTS1
17	RXD4	UART4_ RXD
18	RTS1	UART1_RTS1
19	GND	GND
20	VDD5V	+5V power supply

2.2.11 GPIO&I2C Interface

Table 2-11 GPIO&I2C Interface

CON6		
Pin	**Signal**	**Description**
1	VDD3V3	+3.3V power supply

2	GND	GND
3	VDD3V3	+3.3V power supply
4	GND	GND
5	P4_21	P4[21]
6	I2C2_SCL	I2C2_SCL
7	P4_22	P4[22]
8	I2C2_SDA	I2C2_SDA
9	P4_23	P4[23]
10	P0_04	P0[04]
11	P4_26	P4[26]
12	P0_05	P0[05]
13	P4_27	P4[27]
14	P0_18	P0[18]
15	P4_28	P4[28]
16	P2_25	P2[25]
17	GND	GND
18	VDD5V	+5V power supply
19	GND	GND
20	VDD5V	+5V power supply

2.2.12 CAN&485 Interface

Table 2-12 CAN&485 Interface

J1		
Pin	**Signal**	**Description**
1	+12V	Power supply(+12V) 1.25A (Type)
2	GND_IN	GND for Input +12V
3	CAN1H	CAN1 H
4	CAN1_L	CAN1 L
5	485A	RS485 A

6	485B	RS485 B

2.2.13 Key

Table 2-13 KEY

S1 & SW1～SW2		
Pin	**Signal**	**Description**
S1	RESET	System reset key
SW1	USER1	User-defined key 1
SW2	USER2	User-defined key 2
SW3	ISP	ISP Function key

2.2.14 LED

Table 2-14 LEDs

LED 1～4		
Pin	**Signal**	**Description**
LED 1	P4[15]	User-defined LED 1
LED 2	P4[16]	User-defined LED 2
LED 3	P4[17]	User-defined LED 3
LED 4	P4[18]	User-defined LED 4

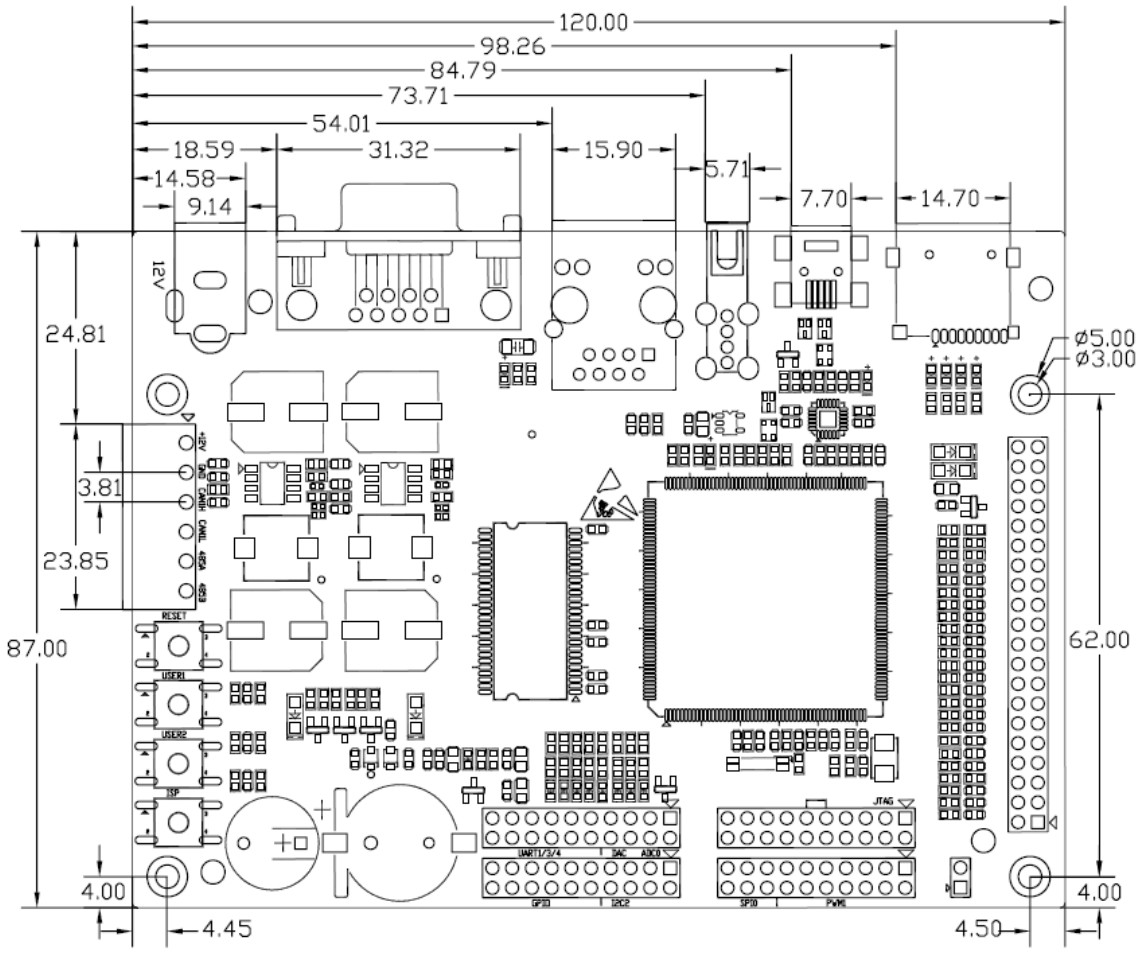
2.2.15 Jumper

Table 2-15 Jumper

JP1		
Jumper	**State**	**Description**
JP1	ON	Power 3.3V to LCD
	OFF	Don’t power 3.3V to LCD (default)

2.3 Hardware Dimension

The hardware dimension of SBC1788 (Unit: mm):



Top Layer Component Height$_{MAX}$ = 13 mm

Bottom Layer Component Height$_{MAX}$ = 3 mm

Board Thick =1.6mm

Charter 3 Software Development

There are mainly two software development environments for LPC177x8x series MCU, Keil MDK-ARM and IAR EWARM. The following sections will give a short description of these softwares and show how to use them.

3.1 Keil MDK

The LPC177x_8x series MCUs require MDK4.20 and newer versions. All MDK projects under folder \MDK-ARM in the CD-ROM are built with **MDK4.22a**.

The sections give a short description of how to use the Keil MDK to develop application software. For more detail, please reference at the related documentation.

3.1.1 Building an existing MDK Project

1) Open a project.

Open *MDK-ARM µVision4 -> File -> Open* and select a project to open.

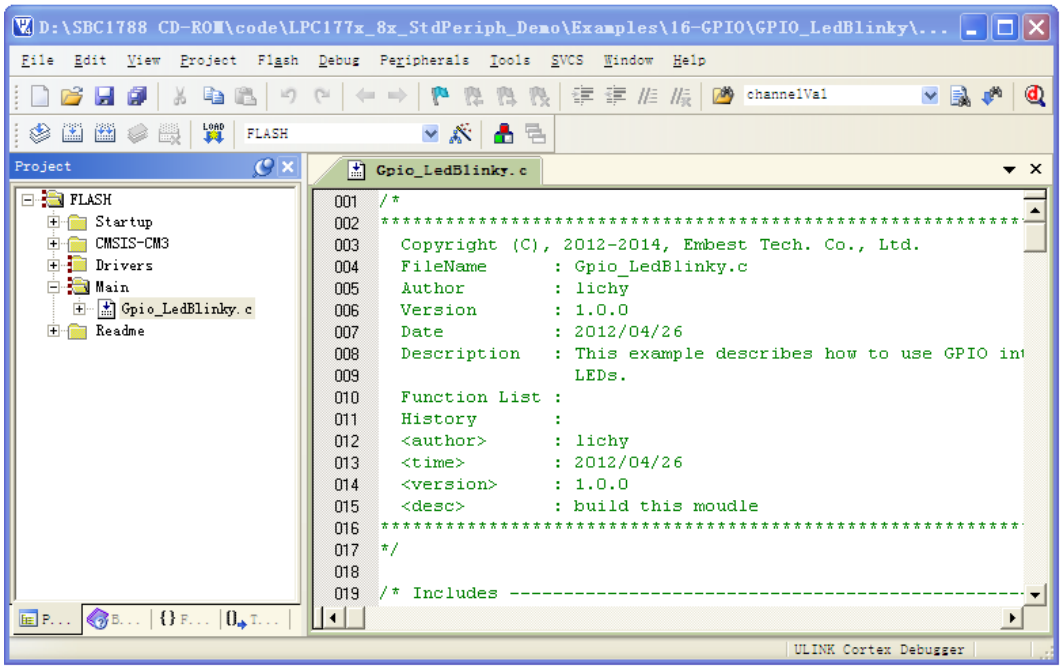


Figure 3-1 Open a MDK project

2) Rebuild the project.

Click “Rebuild” to build or rebuild the project. If the project is successfully compiled, the following window is displayed as the figure shown below.

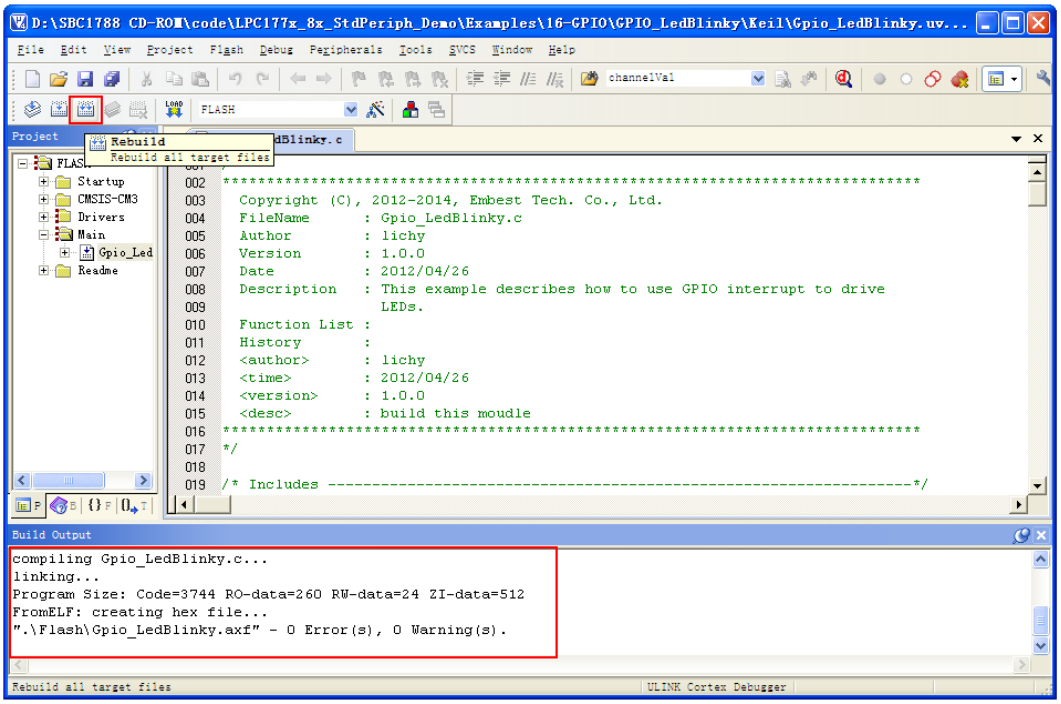


Figure 3-2 Rebuild the project

3.1.2 Downloading program

1) Select your download tool.

Select *Target Options->Utilities* and select your driver for you download tool.

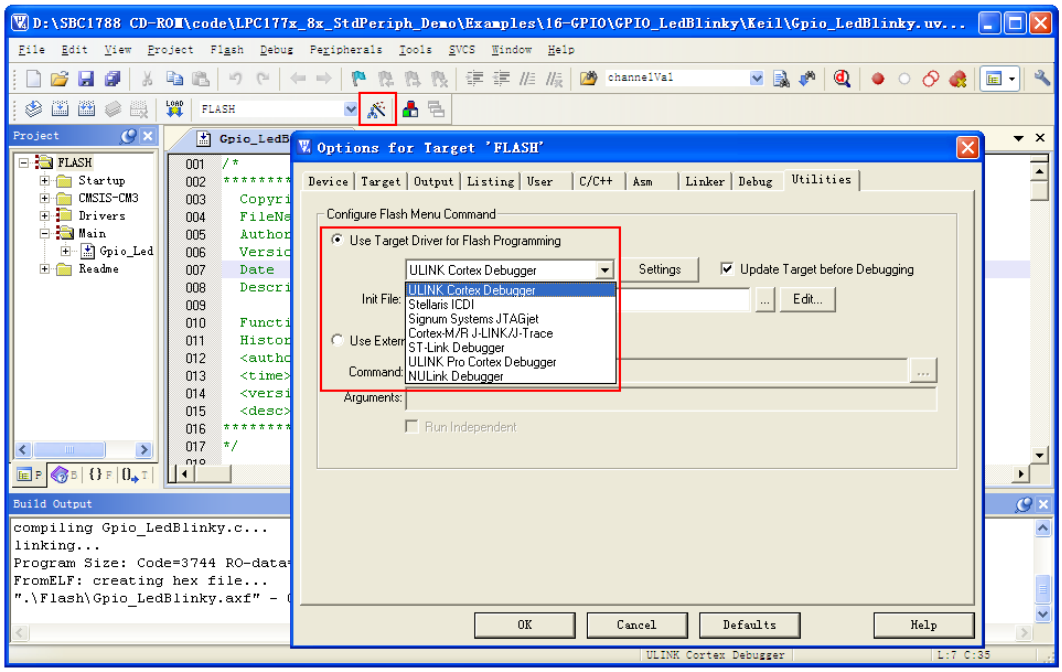


Figure 3-3 Select your download tool

2) Select Flash programming algorithm.

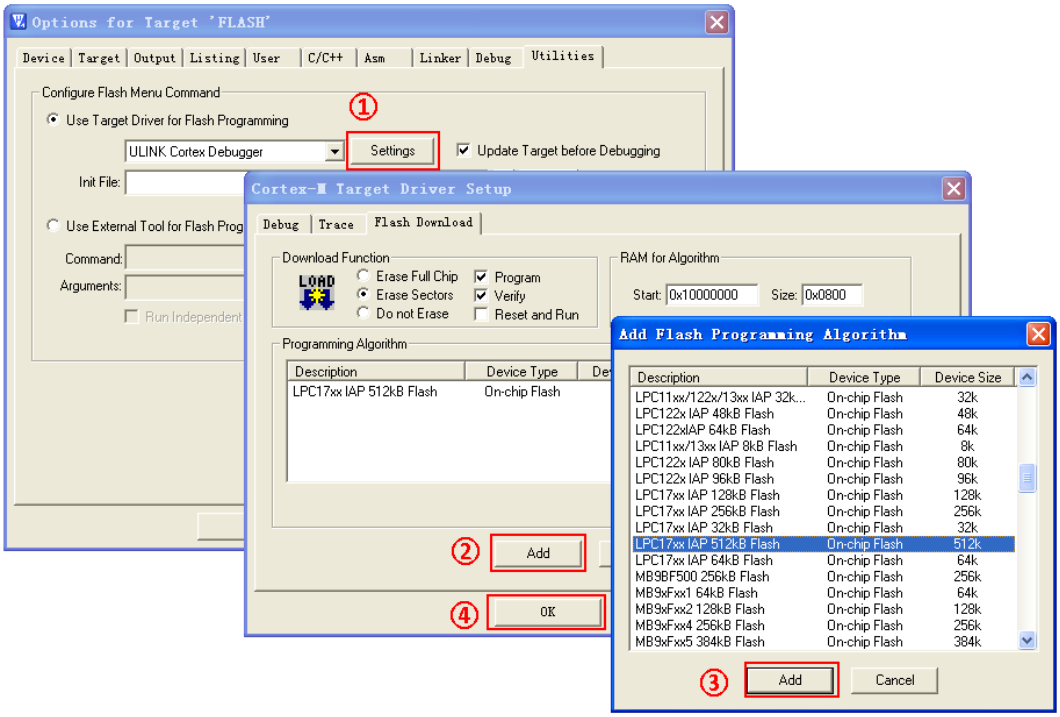


Figure 3-4 Select Flash programming algorithm

3) Download program.

Click *Load* icon or select Flash->Download to download program into flash.

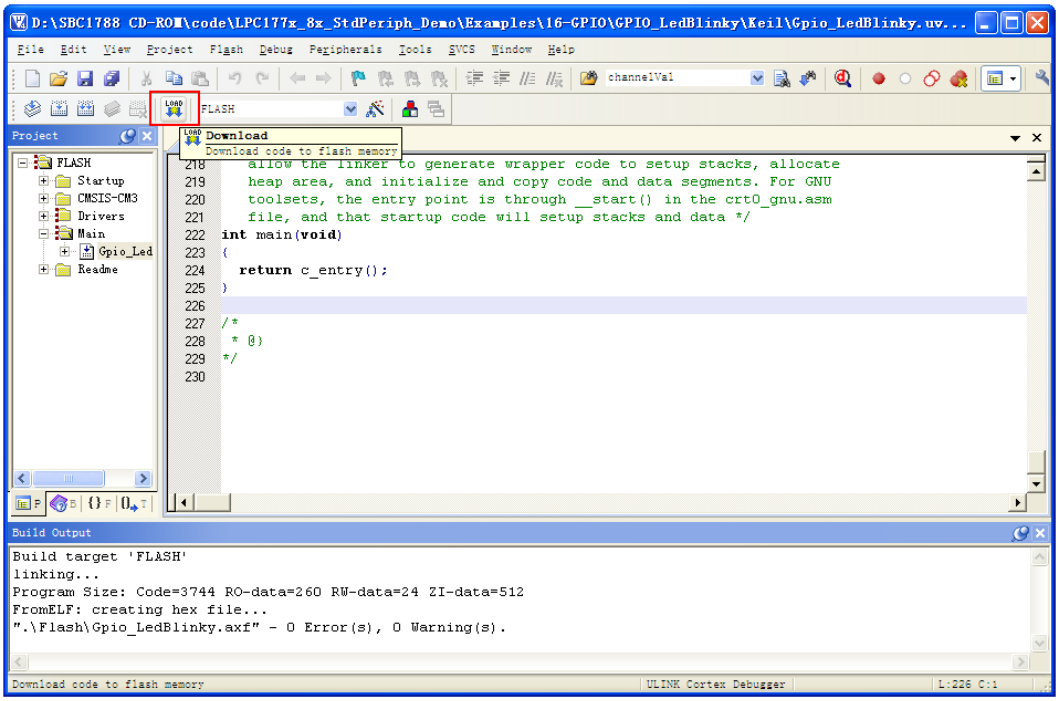


Figure 3-5 Download program

3.1.3 Debugging and running a MDK project

1) Select debug tool

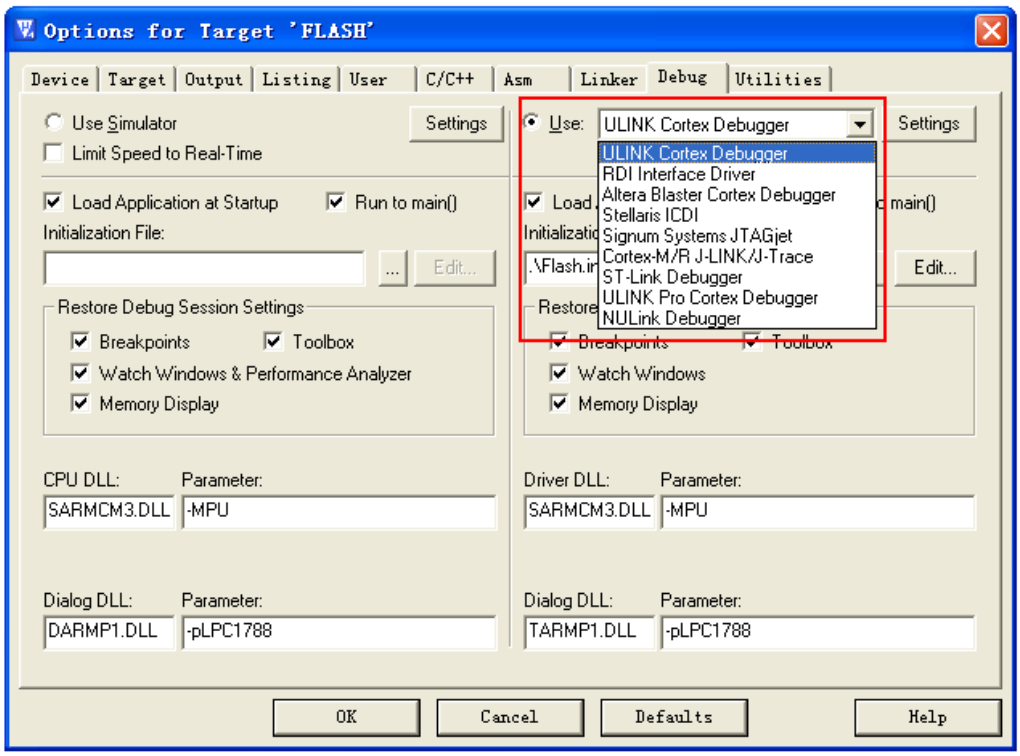


Figure 3-6 Select debug tool

2) Debug project.

Click *Debug* icon or select *Debug->Start/Stop debug session* into debug mode.

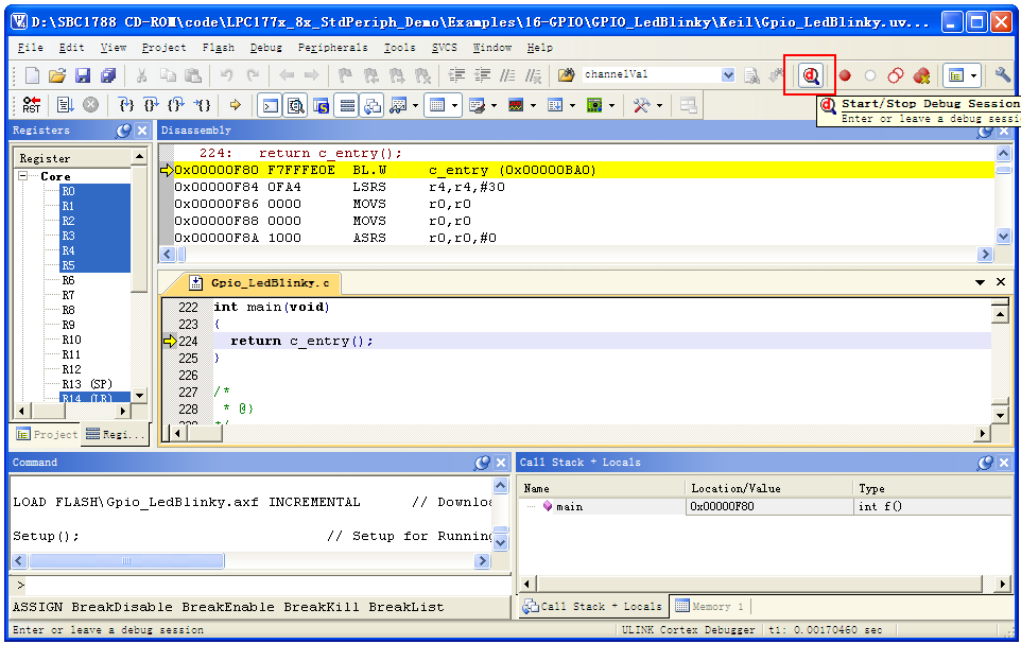


Figure 3-7 Debug project

3.1.4 Creating a New MDK Project

1) Create a new project.

Open MDK µVision4 then Click *Project->New uVision Project*. Save the project.

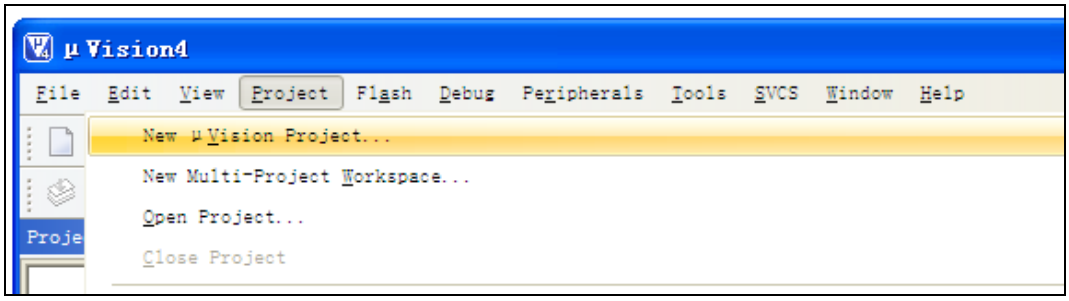


Figure 3-8 Select debug tool

2) Select CPU for new project.

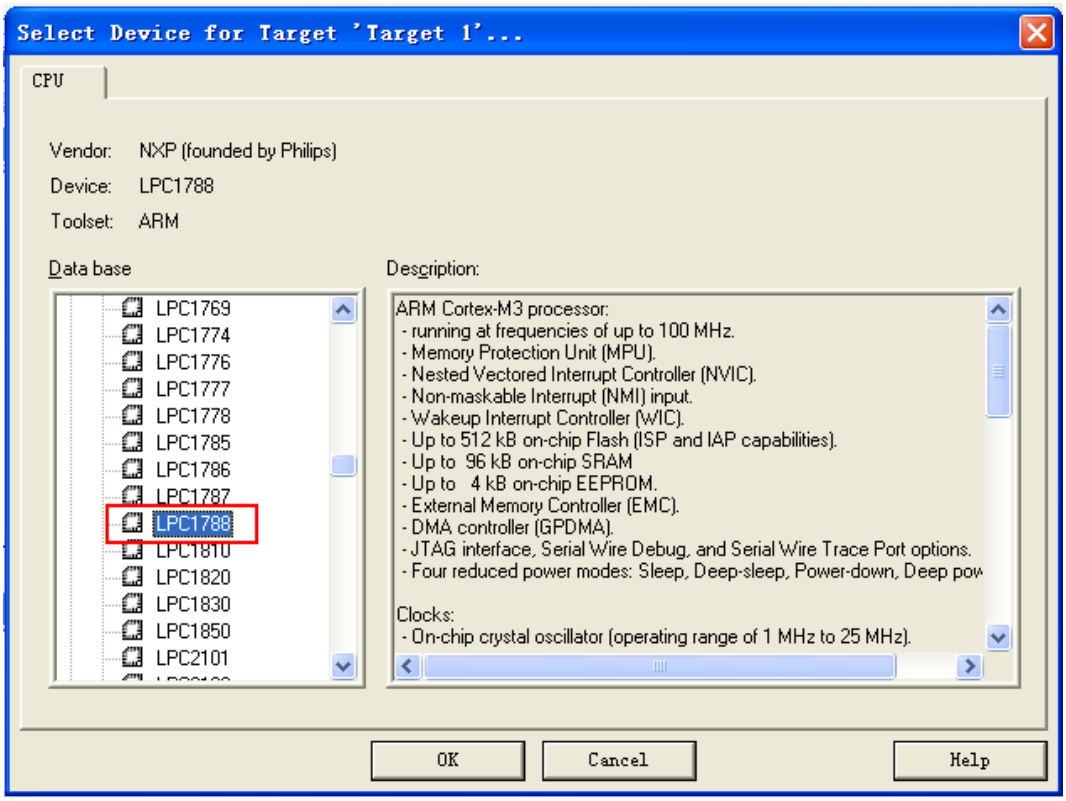


Figure 3-9 Select CPU for new project

3) A dialogue box pops up to ask if you want to add Startup code to project.

You can select “Yes”, uVision will add it for you, or “No” then you need to add it by yourself. The source file of Startup code is located in the folder:

\core\Device\NXP\LPC177x_8x\Source\Templates\ARM

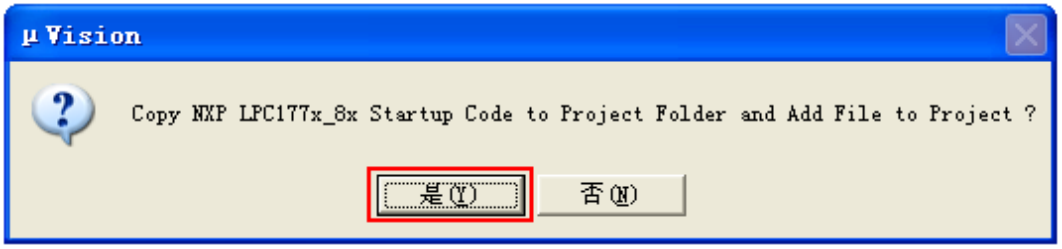


Figure 3-10 Add Start code

4) Now add file groups to project.

Right click on “Target”, select “Add Group…” and name the file group.

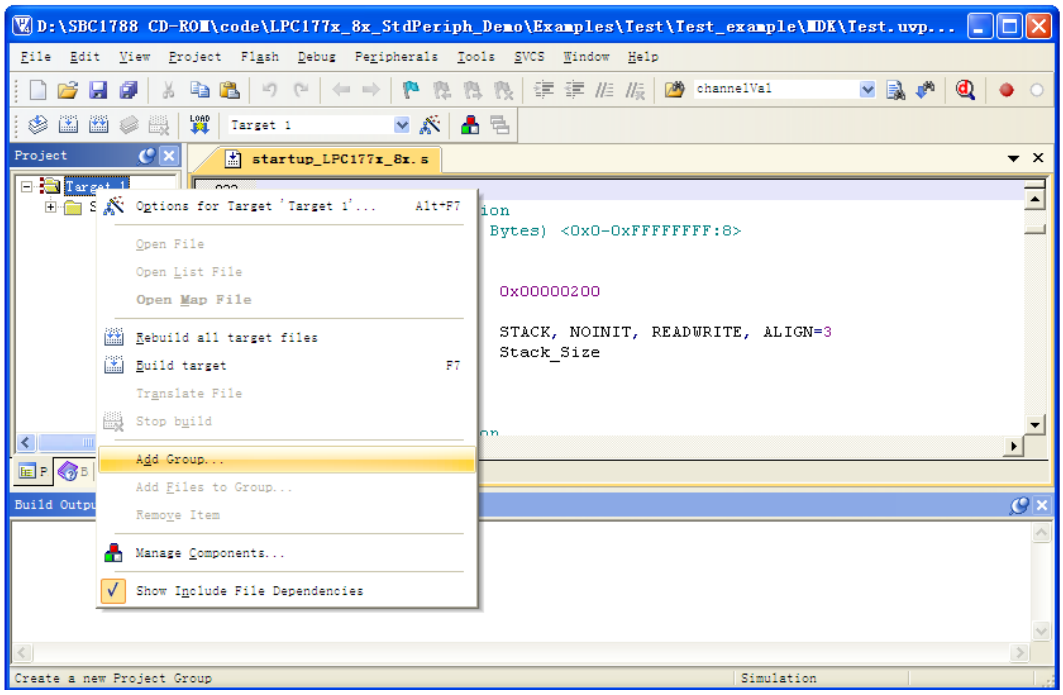


Figure 3-11 Now add file group

5) Add files to group.

Right click on group name and seclect *Add Files to Group…*

In order to organize the source files in an order, please add files to the related group.

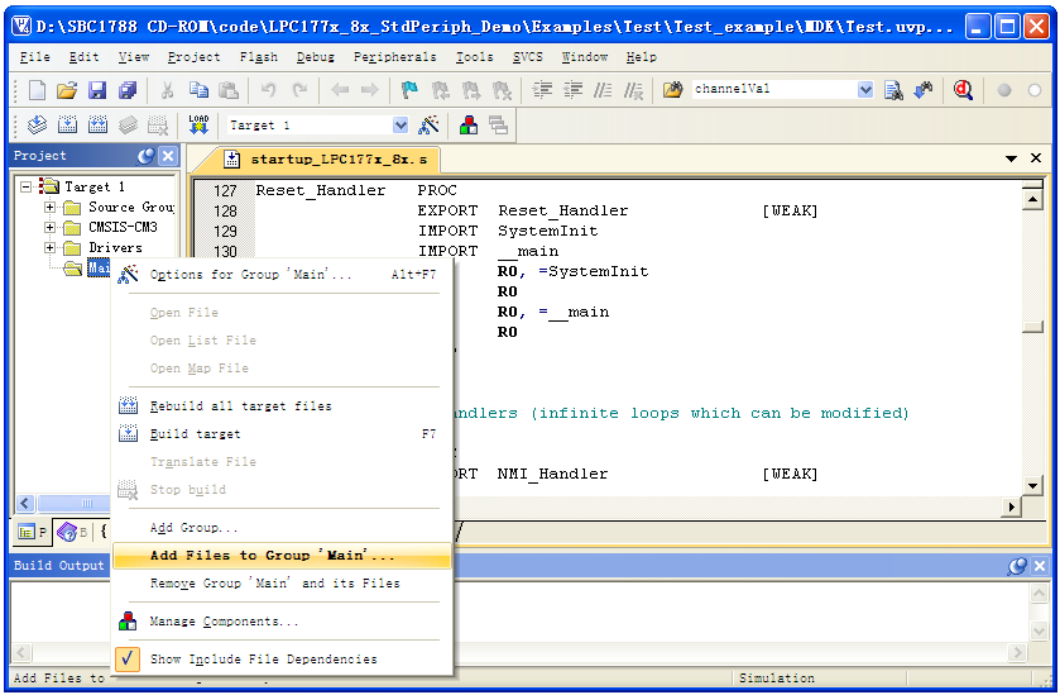


Figure 3-12 Add files to group

6) Setup Target options.

Click the icon “Target Options”.Select ‘C/C++’ tab to and add Include files path.

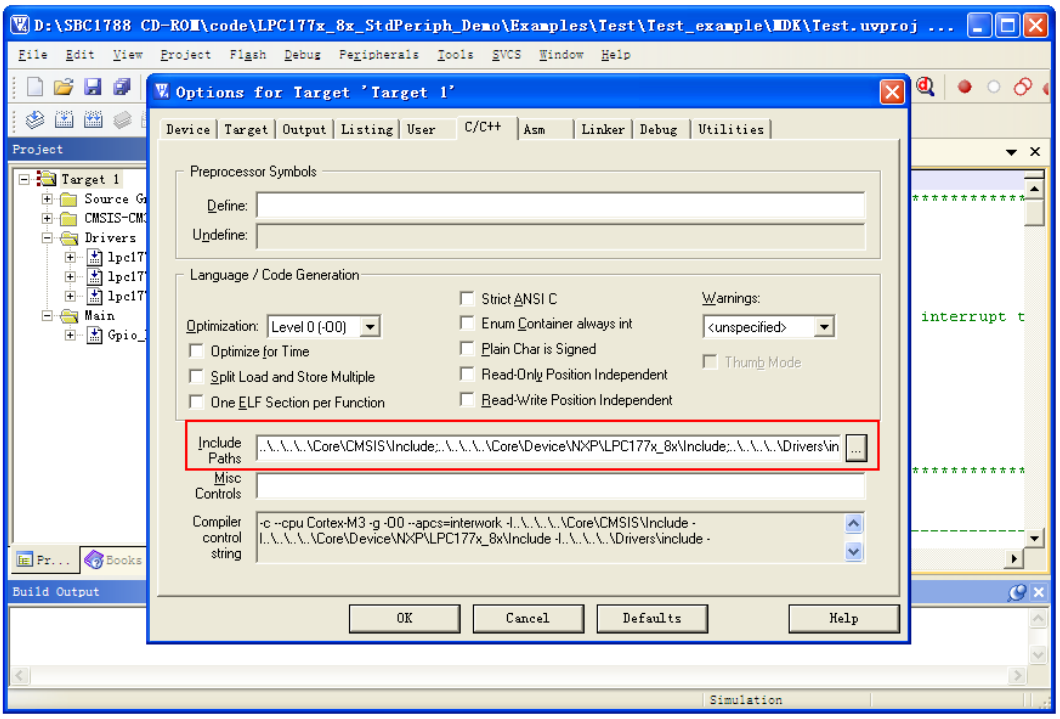


Figure 3-13 Add include file path

7) Rebuild the project.

Please reference at 3.1.1 Building an existing MDK Project.

8) Download the program.

Please reference at 3.1.2 Downloading program.

9) Debug the project.

Please reference at 3.1.3 Debugging and running a MDK project.

3.2 IAR EWARM

The LPC177x_8x series MCUs require IAR EWARM 6.20 and later versions. All IAR projects under folder \EWARM in the CD-ROM are built with IAR EWARM 6.30. User can download the evaluation edition for free from www.iar.com.

The sections 3.2.1 Building an existing EWARM Project and 3.2.4 Creating a New EWARM Project give a short description of how to use the IAR EWARM to develop application software. For more detail, please reference at the related documentation.

3.2.1 Building an existing EWARM Project

1) Open a project.

Open *IAR Embedded Workbench* and select *File -> Open* to open a project.

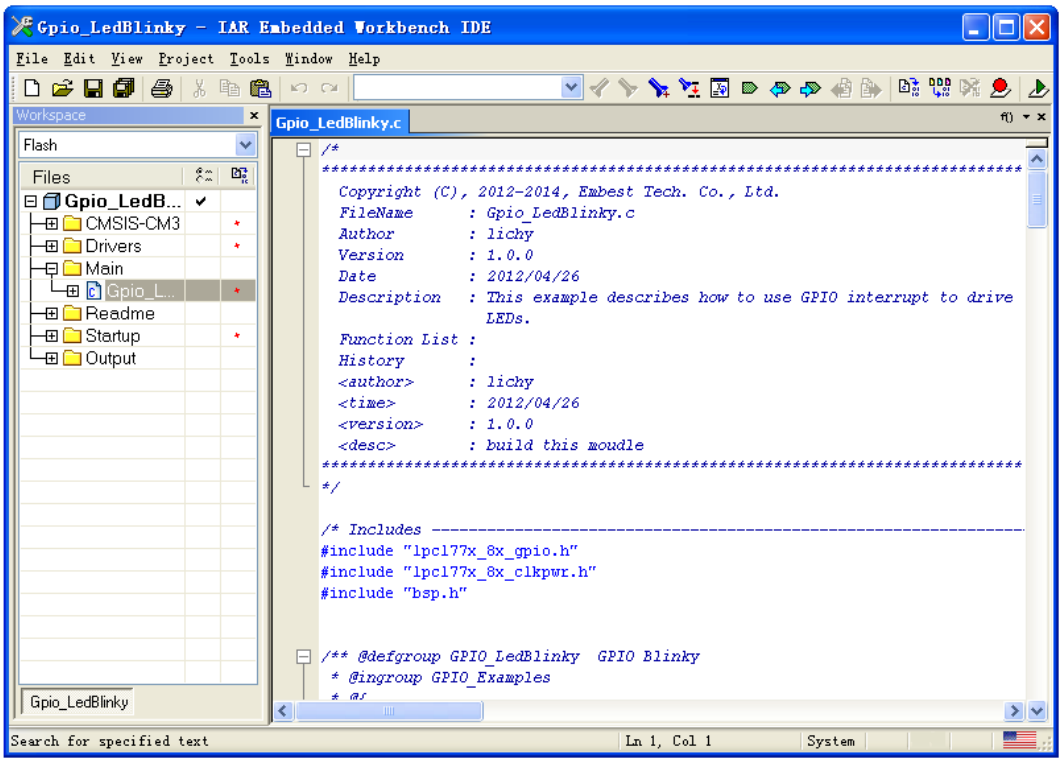


Figure 3-14 Open a project

2) Rebuild the project.

Click icon *Make* or select *Project-> Make / Rebuild All to* rebuild the project.

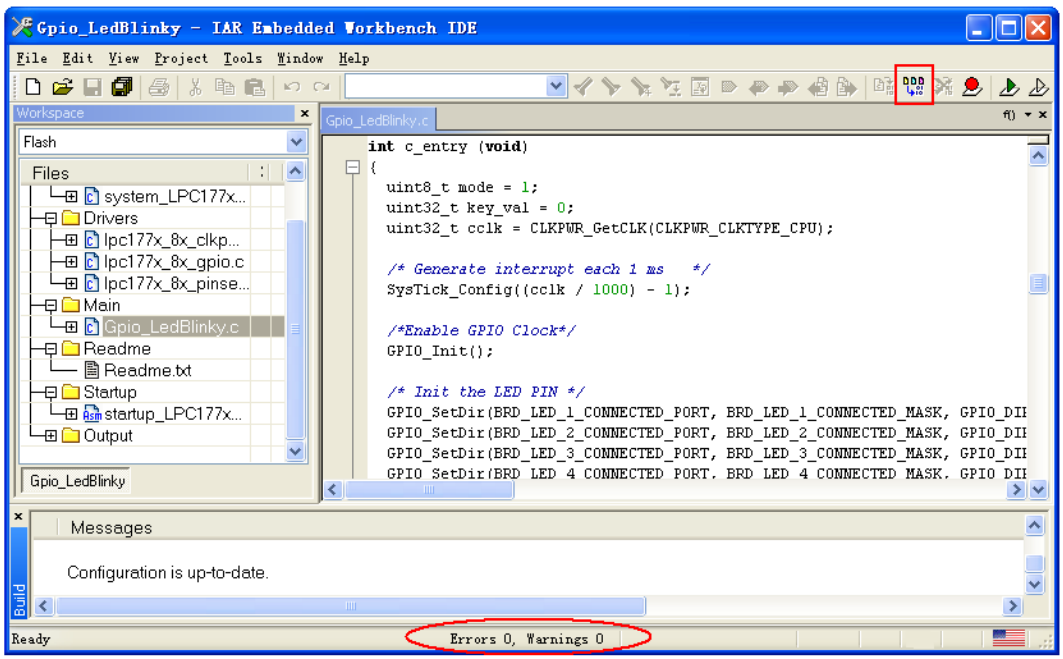


Figure 3-15 Rebuild the project

3.2.2 Downloading and Debugging a EWARM project

1) Select debug and download tool.

Right click on project name in workspace, select *Project -> Options -> Debugger* and select driver for debug and download tool.

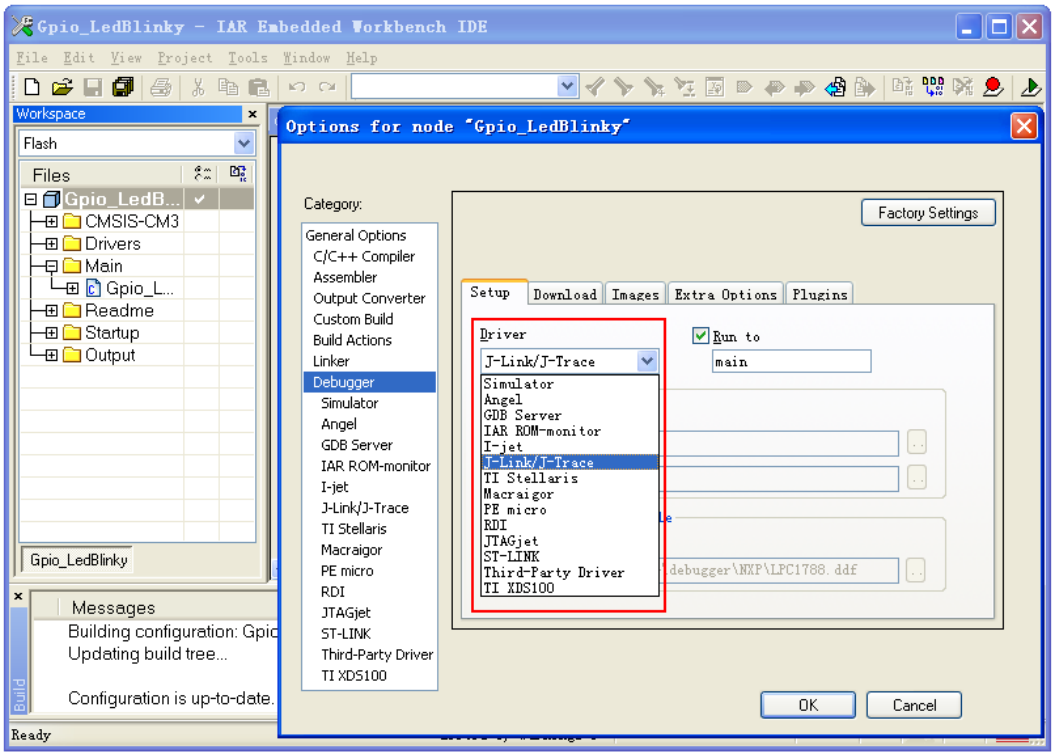


Figure 3-16 Select debug and download tool

2) Select *Verify download*.

Select Debug->Download tab, and then select *Verify download.*

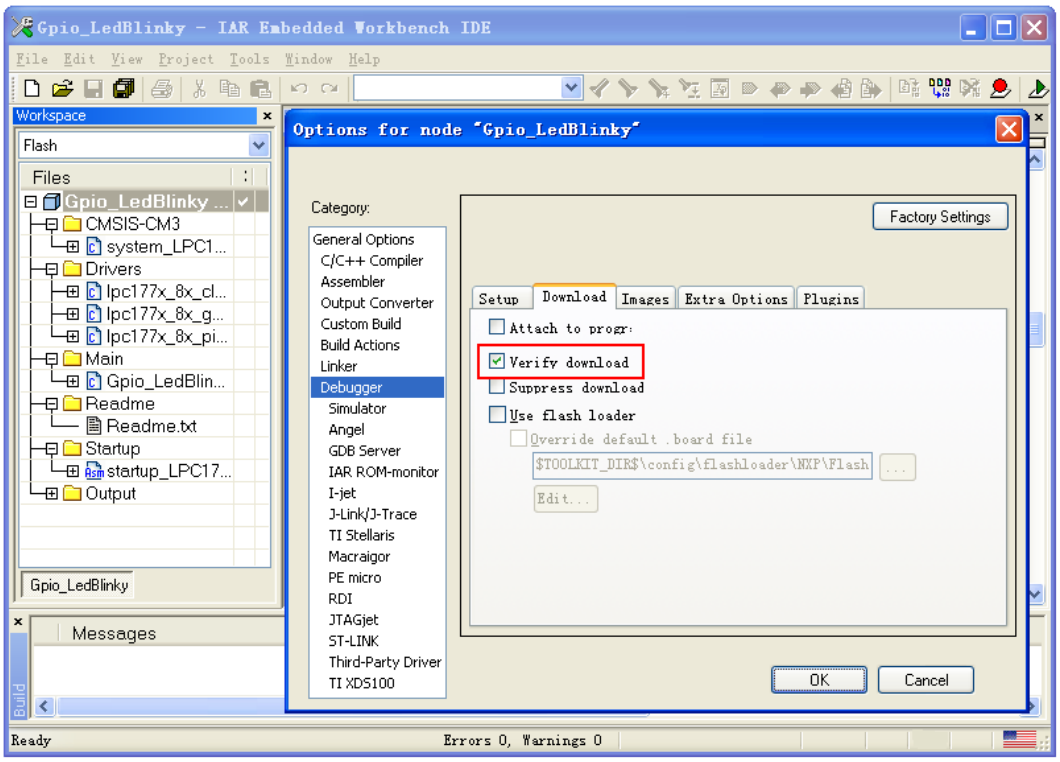


Figure 3-17 Select Verify download

3) Download and debug the project

Click on *Download and debug* icon into debug mode.

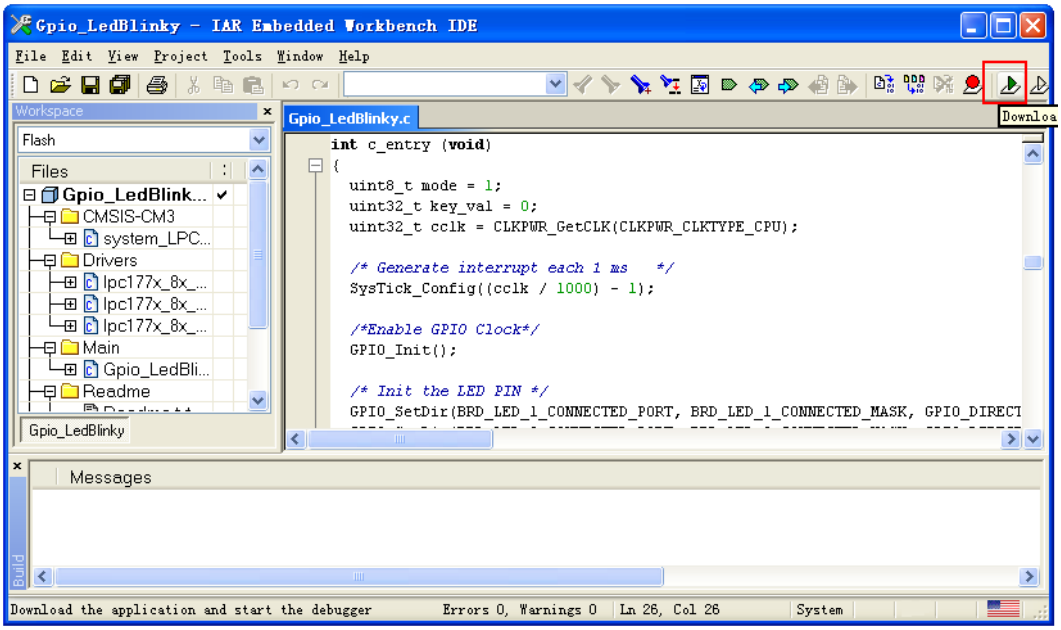


Figure 3-18 Download program

➢ Debug interface display like this:

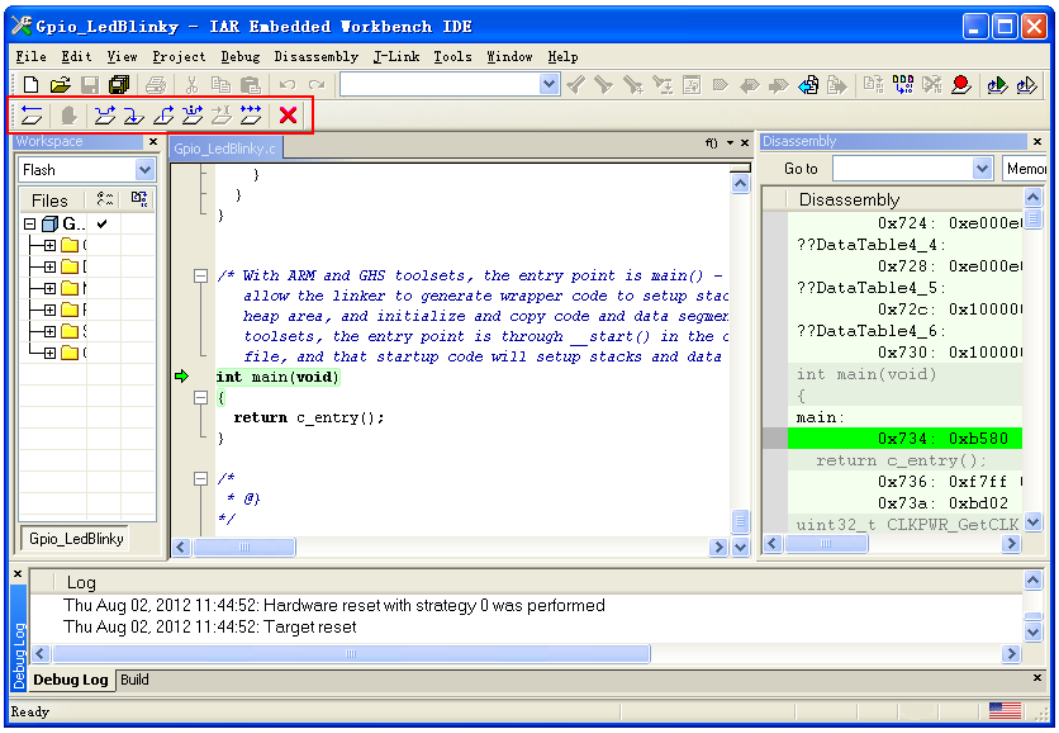


Figure 3-19 Debug interface

3.2.4 Creating a New EWARM Project

1) Create a new project.

Open IAR EWARM then Click *Project->Create new project*. A dialogue box pops up to ask what kind of project template you want to create. Please select *Empty Project* and save the project.

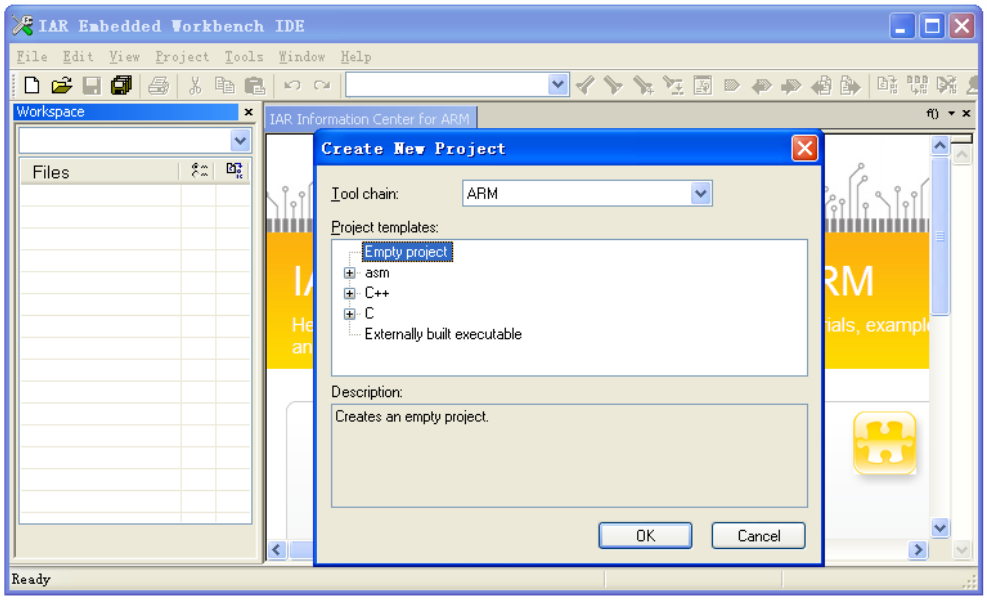


Figure 3-20 Create a new project

2) Add Files Group.

Right click on project name in workspace, select *Add->Add Group.*

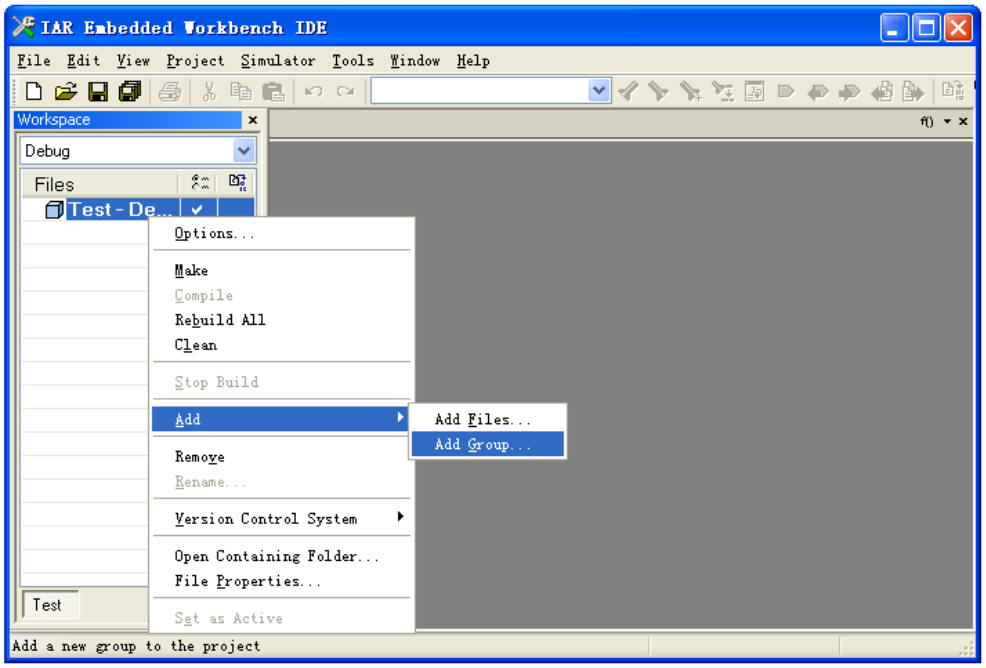


Figure 3-21 Add group

3) Add source file.

Right click on project name in workspace, select *Add->Add file.*

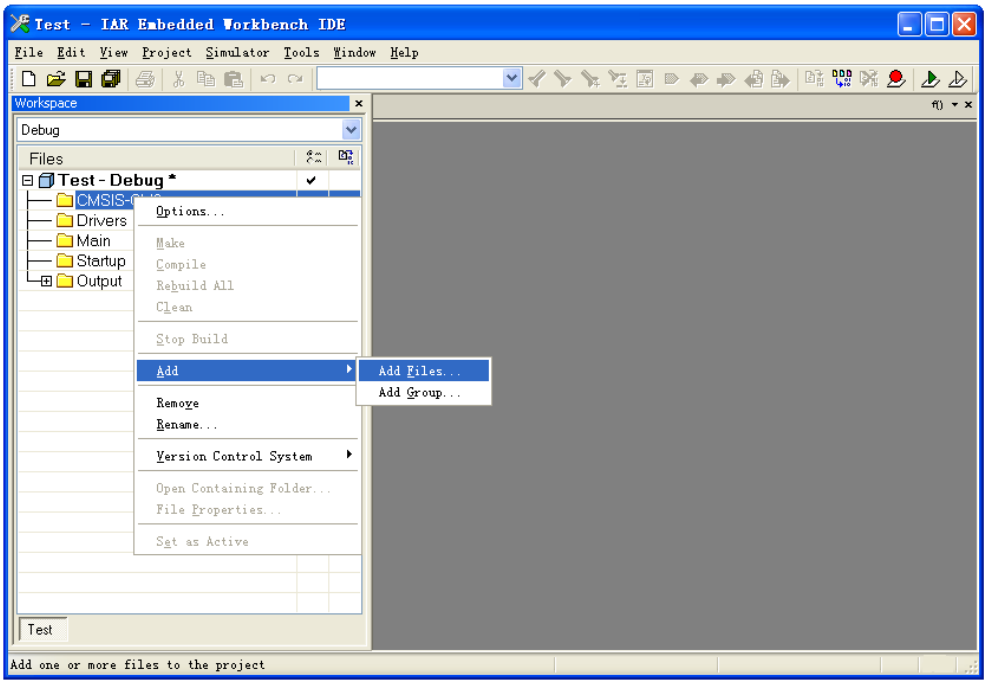


Figure 3-22 Add source file

4) Select CPU for new project.

Right click on project name in workspace, select Options->General options->Target.

Then select NXP LPC1788 for project.

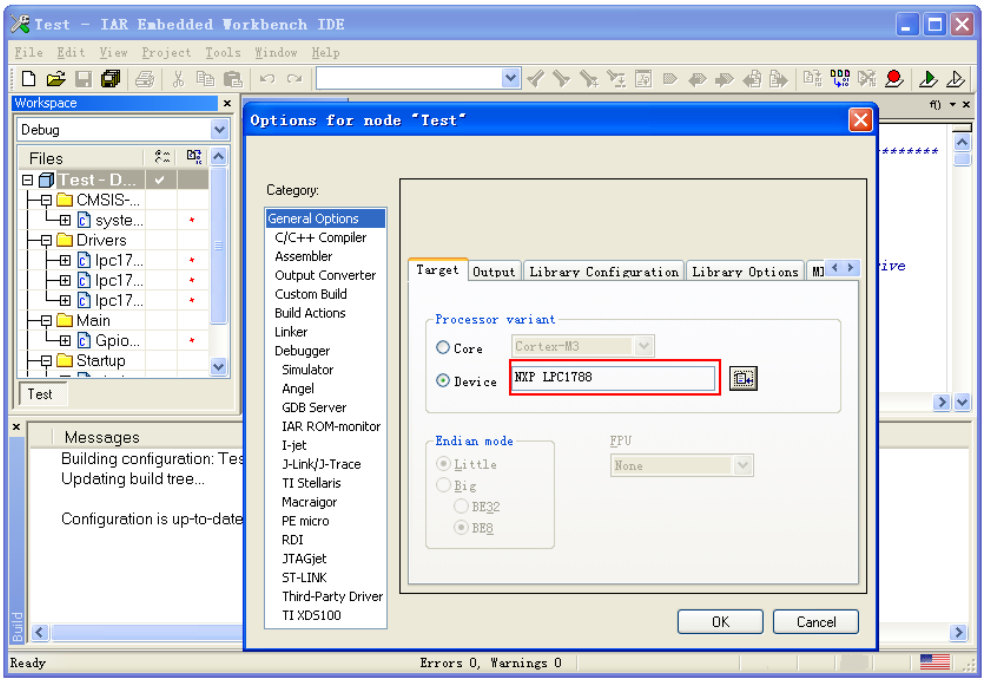


Figure 3-23 Select CPU for new project

5) Setup Target options.

Select *C/C++ Compiler->Preprocessor* tab, then add include file path in *Additional include directories.*

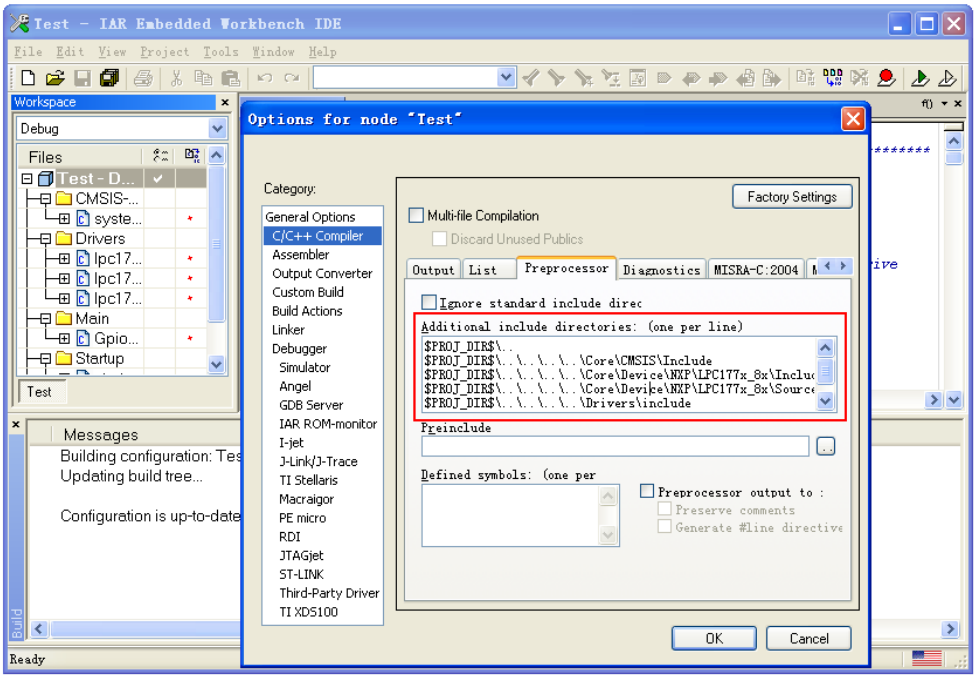


Figure 3-24 Setup Target options

6) Add path of icf (linker configuration file) as shown below:

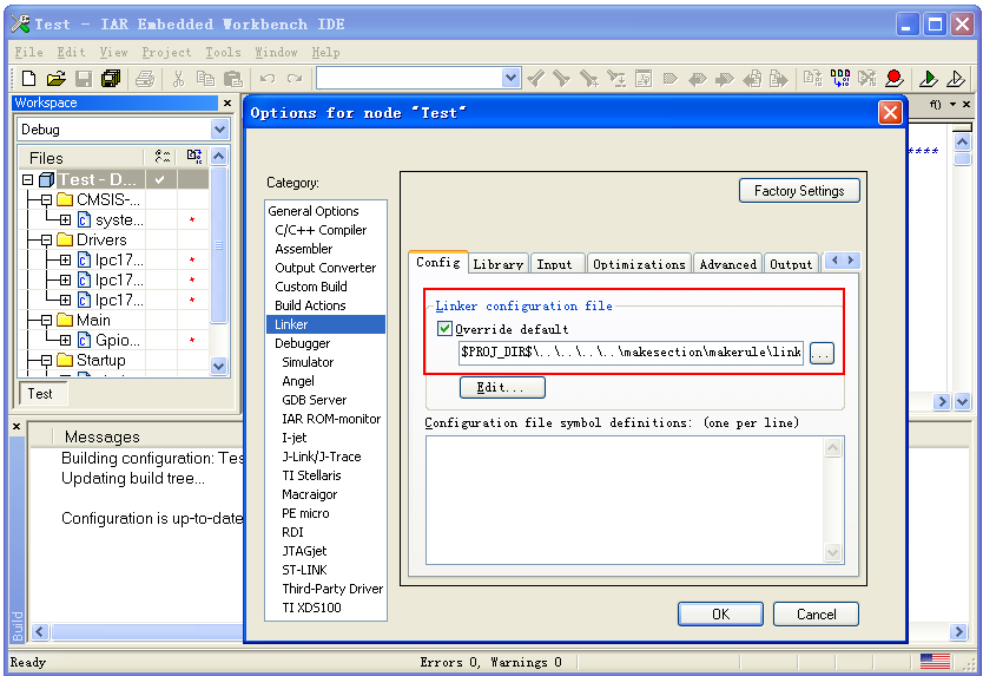


Figure 3-25 Add path of icf file

7) Build the project

Please reference at 3.2.1 Building an existing EWARM Project.

8) Download and debug the project

Please reference at 3.2.2 Downloading and Debugging a EWARM project.

3.3 PC settings

In order to run and test Ethernet and other examples that need print massage via HyperTerminal, PC should do some settings, HyperTerminal connection and network settings.All the settings shown in this article are based on Windows XP OS.

3.3.1 HyperTerminal connection

1) Select *Start -> All Programs -> Accessories -> Communication -> Hyper Terminal*. Find the HyperTerminal, as shown below:

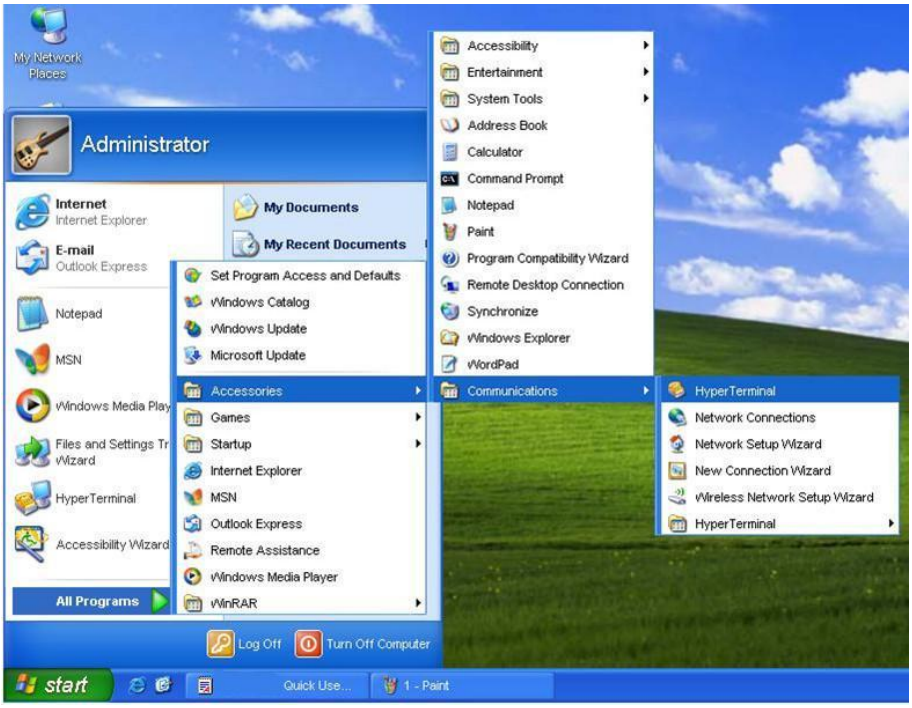


Figure 3-26 Create a new HyperTerminal

2) Create a new HyperTerminal connection, enter a name and choose an icon.

Figure 3-27 Description for new connection

3) Select the specific serial port from the list as per your computer COM port configuration:

Figure 3-28 Select a COM port for connection

4) Set parameters for serial port connection as follows:

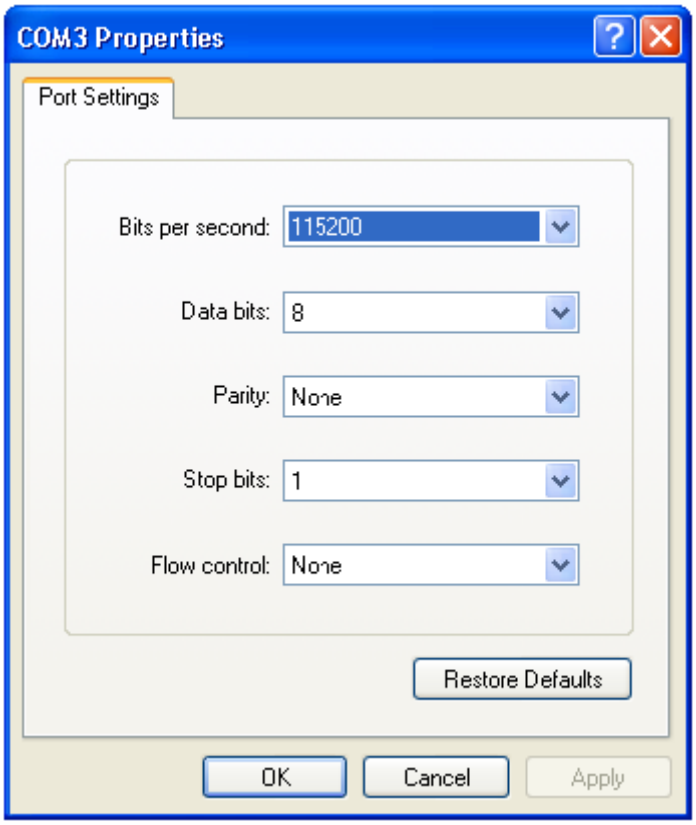


Figure 3-29 Settings for the selected port

5) A Hyper Terminal connection with PC serial port have been established as shown below:

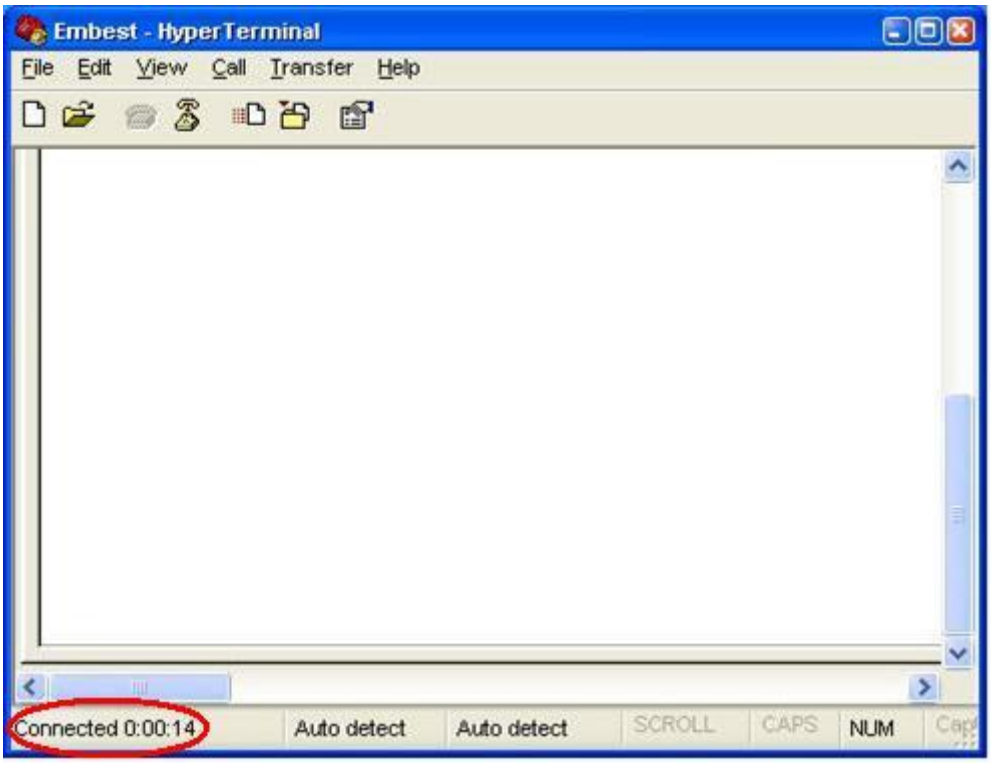


Figure 3-30 Hyper Terminal successfully built

3.3.2 PC network settings

In order to test Ethernet examples, please set up the PC network environment. Make sure that the PC's IP address and the MB407 board's IP address are on the same network.

1) On PC, select *Start-> Control Panel-> Network connections-> Local Area Connection-> Properties*, as shown below:

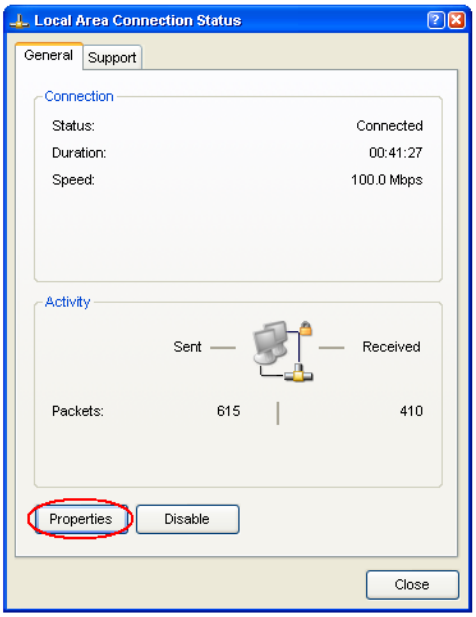


Figure 3-31 Local Area Connection

2) Click 'Properties', this will open the window of Local Area Connection Properties, as shown below:

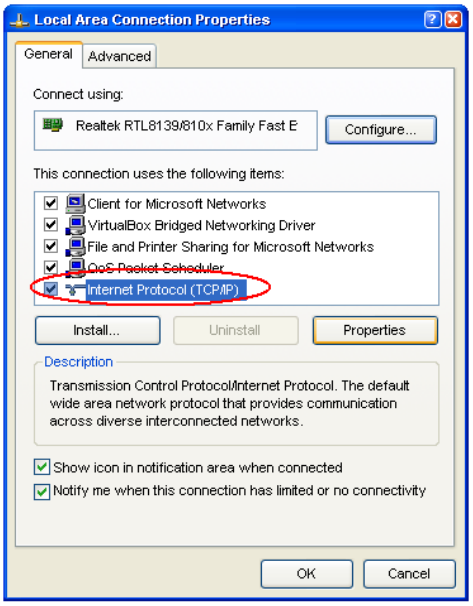


Figure 3-32 Local Area Connection Properties

3) Double click ‘TCP / IP Options’, opens a window for TCP / IP Properties, as shown below:

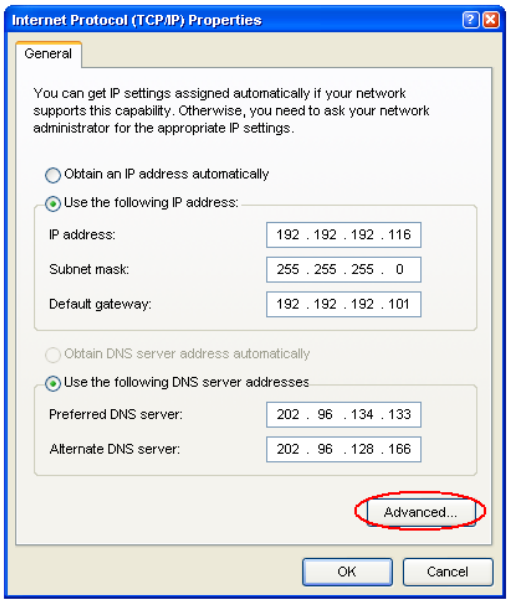

Internet Protocol (TCP/IP) Properties
General
You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.
Obtain an IP address automatically
Use the following IP address:
IP address: 192 . 192 . 192 . 116
Subnet mask: 255 . 255 . 255 . 0
Default gateway: 192 . 192 . 192 . 101
Obtain DNS server address automatically
Use the following DNS server addresses
Preferred DNS server: 202 . 96 . 134 . 133
Alternate DNS server: 202 . 96 . 128 . 166
Advanced...
OK
Cancel

Figure 3-33 TCP / IP Options

4) Click the ‘Advanced’ option, open a window for “Advanced TCP / IP settings”, as shown below:

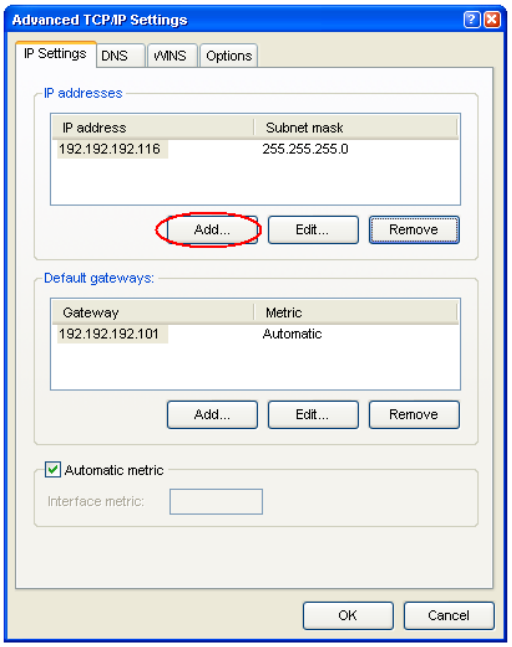


Figure 3-34 Advanced TCP / IP settings

5) Click the ‘Add’ option; open a window for "Add TCP / IP".

Enter the IP address (must not be 192.168.0.100, because it is default IP address for SBC1788) and subnet mask, then click "Add”, as shown below:

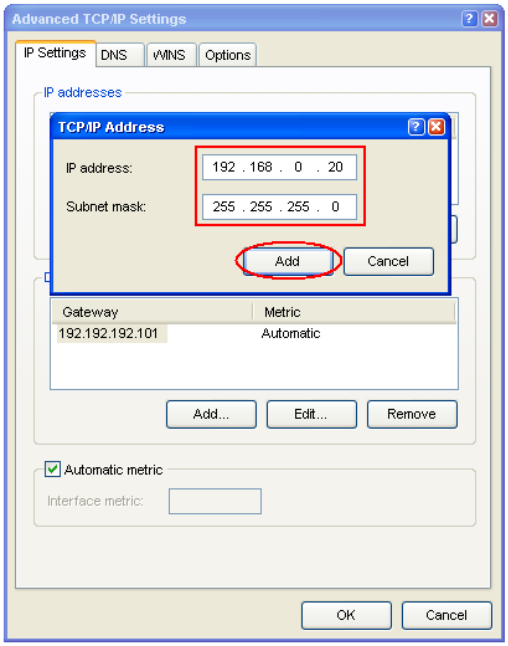


Figure 3-35 Add TCP/IP address

6) Click “OK” to finish network setup.

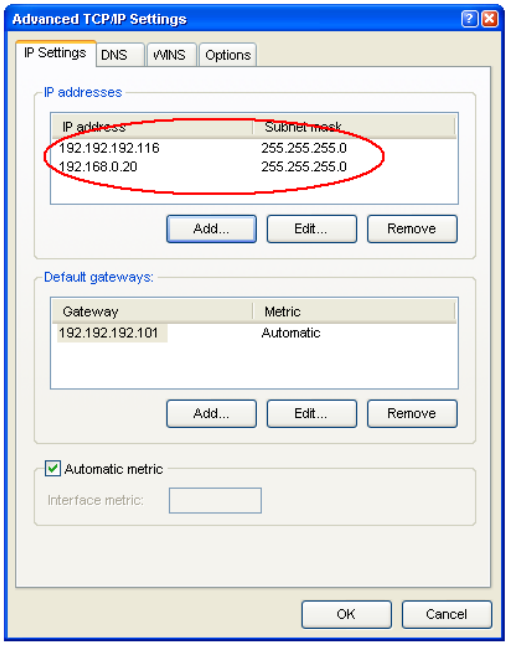


Figure 3-36 TCP/IP address successfully setup

3.4 Flash magic

LPC1788 supports ISP over UART for program download.

ISP is short for In-System Programming. The LPC1788 contains a bootloader in ROM that can be enabled by pulling pin P2.10 low during reset. The application can then be downloaded over UART#0 (serial channel).

In order to run ISP, please follow steps as below:

1) Connect a null-modem female/female RS232 cable between the DB9 connector COM1 (USART0) and PC serial port.
2) Plug in +12V power supply.
3) Create HEX file with MDK-ARM.
   - Open MDK-ARM project, configure *Target Option* and select *Create HEX file*.
   - Rebuild the Project, generate HEX file.
   - The hex file is located in *\Keil\Flash* subfolder of the project directory.

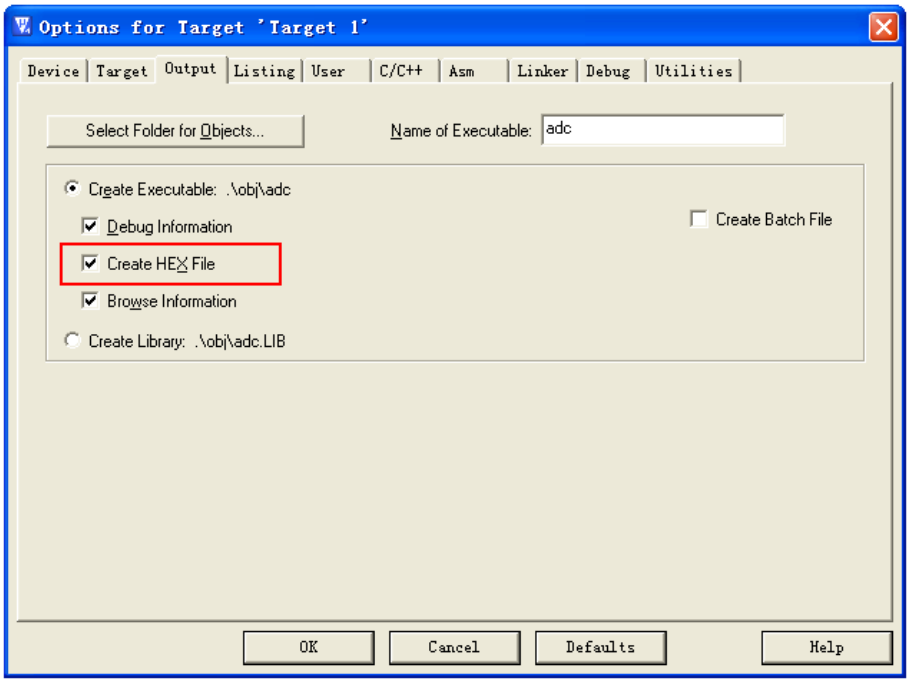


Figure 3-37 Configure MDK output option

4) Create HEX file with IAR EWARM.
   - Open EWARM project, configure *Options* and select *output format.*
   - Select *Intel extended* for *output* .Rebuild the Project, generate hex file.

➢ The hex file is located in *\EWARM\Flash\Exe* subfolder of the project directory.

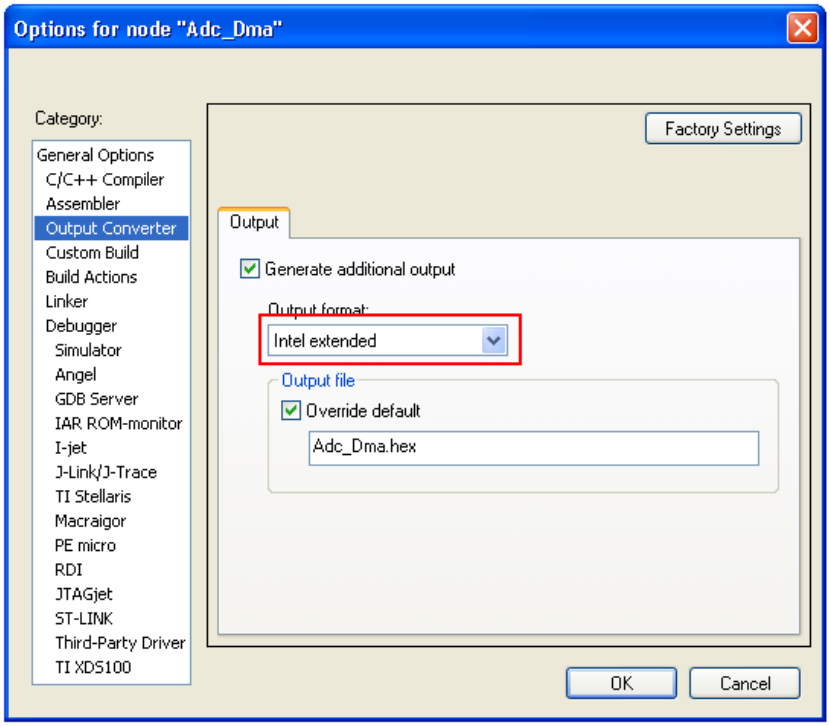


Figure 3-38 Configure EWARM output option

5) Install *Flash Magic* software. The software is located in the folder of *\Flash Magic.*

6) Open *Flash magic* software, and then select *Options->Advanced Options*.

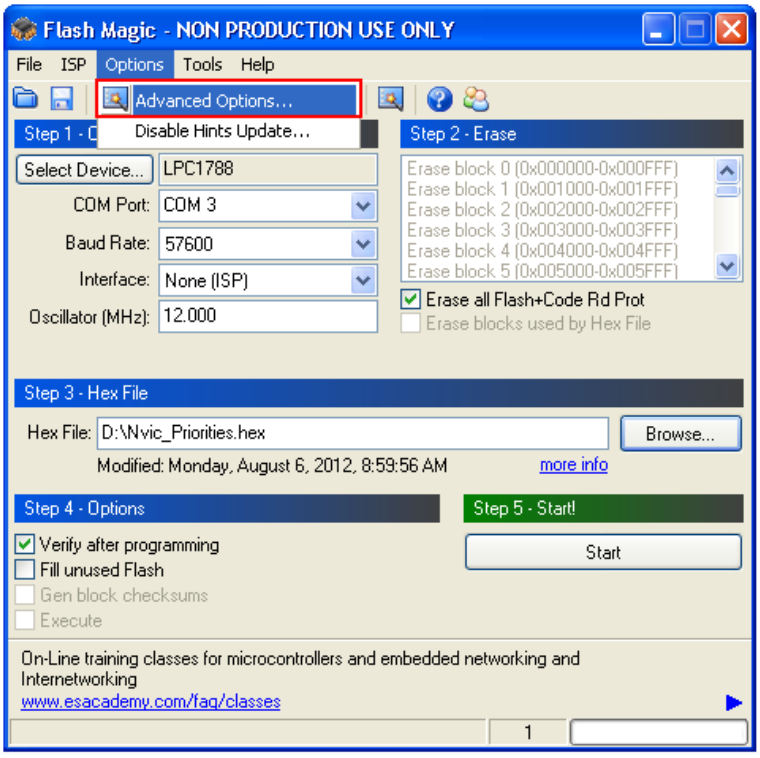


Figure 3-39 Flash Magic Advance Options

7) Then select the *Hardware Config* tab end set checkboxes and T1/T2 numbers according to figure below.

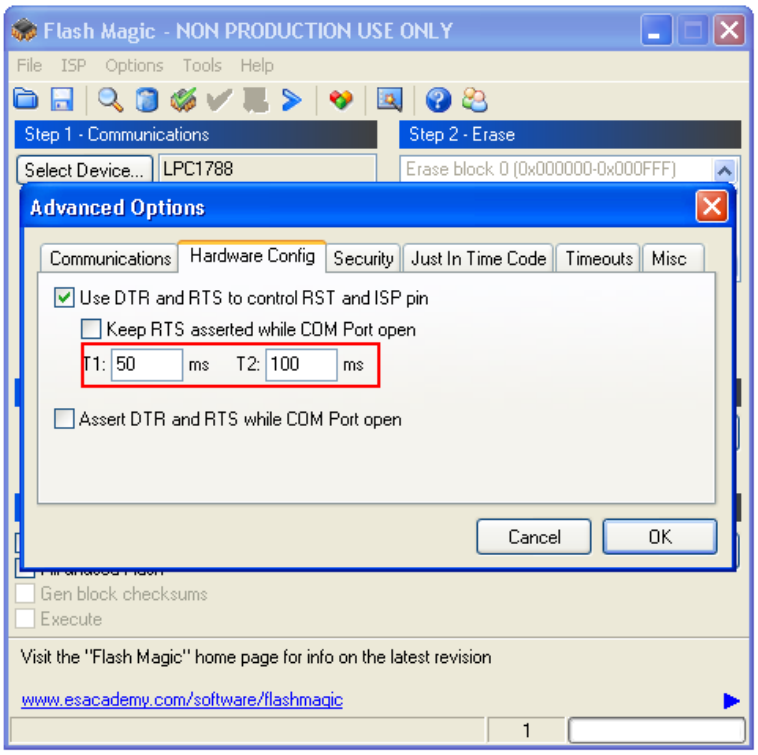


Figure 3-40 Flash Magic Hardware Config

8) Flash magic settings.

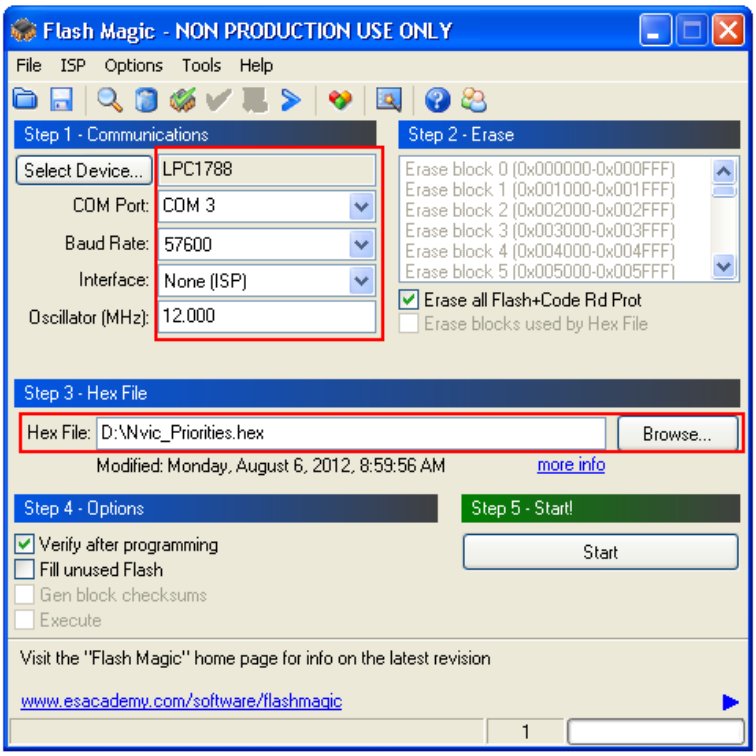


Figure 3-41 Flash Magic settings

- Communications
  - Select Device: LPC1788
  - COM Port: According to your PC serial port
  - Baud Rate: Shall be set to 57600 or lower
  - Interface: None (ISP)
  - Oscillator (MHz): Shall be set to 12.000
- Hex File

  Select the hex/binary file to be downloaded.

9) Download hex file

- ISP (SW3) button maintained pressed. Press RESET button and cilk *Start* icon to start downloading the hex file.
- After download finish, release ISP (SW3) button. Press RESET button. After reset, the MCU start to run.

Charter 4 Peripheral examples

Embest provides plenty of peripheral examples. All the peripheral examples are based on the peripheral driver library.

The structure of peripherals examples is shown in figure below.

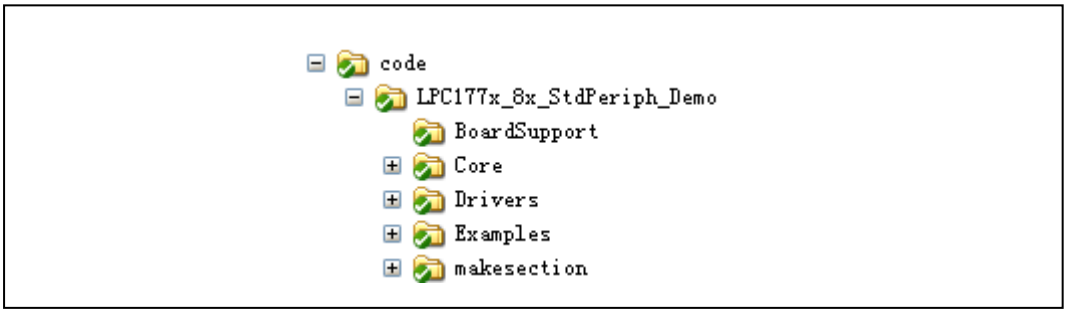


Figure 4-1 Peripherals examples structure

Description of \code\LPC177x_8x_StdPeriph_Demo folder

1) BoardSupport subfolder

   This folder contains source of SDRAM, Nand Flash, LCD and Phylan drivers.

2) Core subfolder

   This folder contains the CMSIS files and startcode for Keil and IAR.

3) Drivers subfolder

   This subfolder contains sources of LPC1788 peripheral drivers.

   Each peripheral has a source code file, lpc177x_8x_ppp.c, and a header file, lpc177x_8x_ppp.h.

4) Examples subfolder

   This subfolder contains a set of examples for some peripherals with preconfigured projects for EWARM, MDK-ARM toolchains.

The sections in this charter give a description of some peripheral examples. User can learn about the feature of LPC1788 peripherals and how to use them by reading these sections. Some examples may require additional hardware such as an oscilloscope. For further information on the required hardware, please reference at the Readme file provided within each example folder.

4.1 LCD example

The LCD folder contains two examples:

- LCD_Display
- LCD_Touch

4.1.1 LCD_Display

1. Purpose

LCD_Touch example describes how to test touch screen and do calibration on SBC1788.

2. Description

In this example, four points on the corner of touch screen need to be touch to complete calibration.

3. Hardware configuration

SBC1788 supports two kinds of LCD & Touch Screen module:

- LCD6000-43T, 4.3 inch, resolution: 480*272
- LCD6000-70T, 7 inch, resolution: 800*480

Mount LCD module onto SBC1788 CON9 through LCD cable. Red line onside indicates the first pin of LCD cable. Triangle onside indicates the first pin of LCD connector.

Note: Make sure that LCD module mount onto SBC1788 correctly.

4. Software configuration

Do the change in the file lcd_driver.h according to LCD module:

- If 4.3 inch LCD module be used:

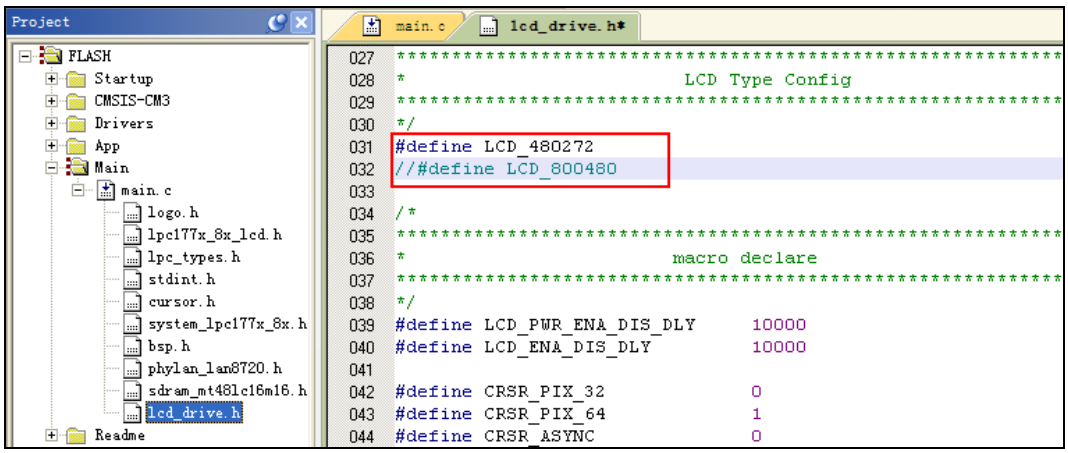


Figure 4-2 Change macro for 4.3 inch LCD module

- If 7 inch LCD module be used

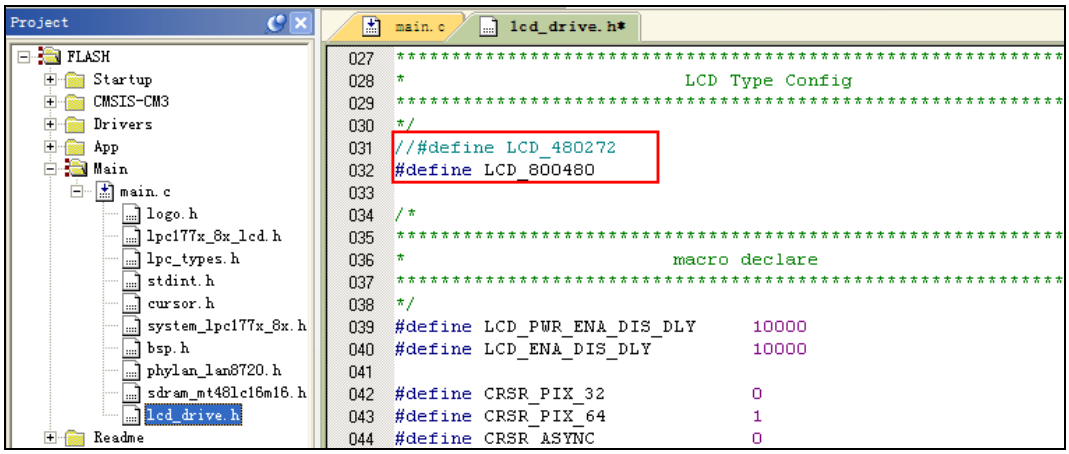


Figure 4-3 Change macro for 7 inch LCD module

5. Steps to run

1) Mount LCD module onto SBC1788 CON9 through LCD cable.

2) Plug in +12V adaptor and power the board.

3) Rebuild the example, and then download the program into SBC1788 Flash.

4) Reset SBC1788 and run the example on the board.

5) Testing actions and results:

   - The LCD displays 4 color bars, red, green, blue and yellow.
   - A blue cursor moves from one side to another side on the red bar.

4.1.2 LCD_Touch

1. Purpose

LCD_Touch example describes how to test LCD module on SBC1788.

2. Description

The LCD displays 4 color bars, red, green, blue and yellow. A blue cursor moves from one side to another side on the red bar.

3. Hardware configuration

SBC1788 supports two kinds of LCD module:

- LCD6000-43T, 4.3 inch, resolution: 480*272
- LCD6000-70T, 7 inch, resolution: 800*480

Mount LCD module onto SBC1788 CON9 through LCD cable. Red line onside indicates the first pin of LCD cable. Triangle onside indicates the first pin of LCD connector.

Note1:

- ***Make sure that LCD module mount onto SBC1788 correctly.***
- ***If 4.3 inch LCD be used, please remove C3, C5, C6 and C7 from the board. C3, C5, C6 and C7 are designed for improving EMC performance, while they may degrade touch screen performance.***

4. Software configuration

Do the change in the file lcd_driver.h according to LCD module:

- If 4.3 inch LCD module be used:

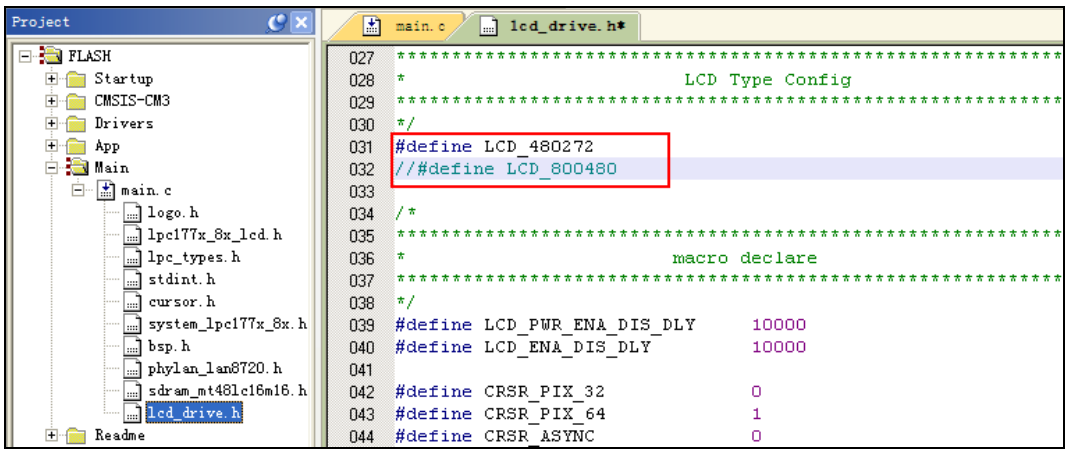


Figure 4-4 Change macro for 4.3 inch LCD module

- If 7 inch LCD module be used

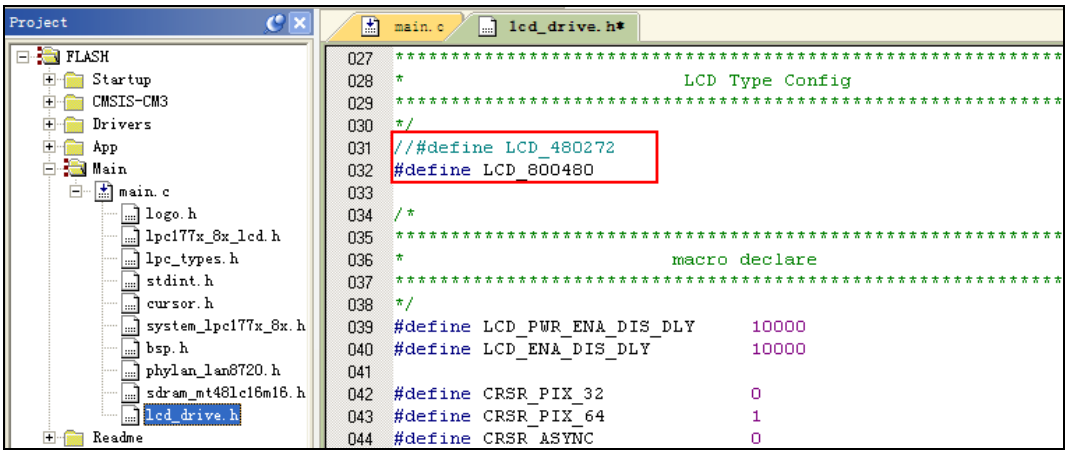


Figure 4-5 Change macro for 7 inch LCD module

5. Steps to run

1) Mount LCD module onto SBC1788 CON9 through LCD cable.

2) Plug in +12V adaptor and power the board.

3) Rebuild the example, and then download the program into SBC1788 Flash.

4) Reset SBC1788 and run the example on the board.

5) Testing actions and results:

   - Click calibration points accurately using a touch pen.
   - LCD will give massage whether calibration is OK. If calibration is OK, then MCU will enter into Calibration_Test_Dispose function.
   - In this function LCD will display the value of points touched by the pen. Both ADC values and coordinate values are displayed.

4.2 USB-Device

The USB folder contains two examples:

- USB_MassStorage
- USB_VirtualCom

4.2.1 USB_MassStorage

1. Purpose

This example describes how to write a simple USB Mass Storage application on LPC177x_8x.

2. Description

The MassStorage project is a Mass Storage simple demo run on LPC177x_8x.

It demonstrates an USB Memory based on USB Mass Storage Class. The USB Memory is automatically recognized by the host PC running Windows which will load a generic Mass Storage driver.

3. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

4. Steps to run

1) Connect SBC1788 to a PC with a 'USB type A to Mini-B' cable through USB connector CON1.
2) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
3) Plug in +12V adaptor and power the board.
4) Rebuild the example, and then download the program into SBC1788 Flash.
5) Reset SBC1788 and run the example on the board.
6) Testing actions and results:

- After reset, see UGL (USB Good Link), then open “My Computer” on PC to check “LPC177x_8x” disk drive.LED6 turn on.
- Open the disk, “Readme.txt” file will shown with read-only attribute.

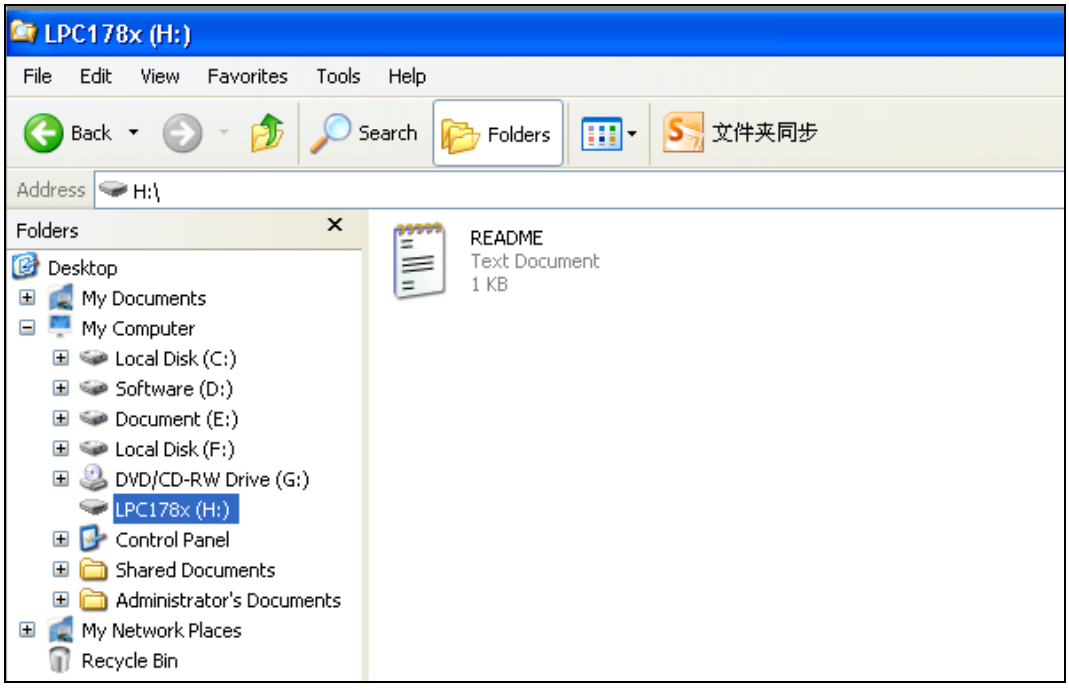


Figure 4-6 Readme.txt file in LPC178x disk

- Try handling data inside (as create, copy, delete...)->They are all ok.

4.2.2 USB_VirtualCom

1. Purpose

This example describes how to configure USB Device of as a virtual COM port.

2. Description

The PC will install a virtual COM port on the PC (see Driver Installation).

After installation an additional port "LPC177x_8x USB VCom Port(COMx)" can be found under System/Hardware/Device Manager/Ports(COM&LPT).

Number "x" is not fixed as different PC configuration may have different "x" displayed on the device manager. The USB host driver assigns "x" dynamically based on the existing COM port configuration of the system.

To test the virtual COM Port that just linked, it should:

- Use one more standard UART connection between the board and the PC
- Checking if data transmitting from PC through standard COM to the board then back to PC through virtual COM is correct or not

And oppositely checking if data transmitting from PC through virtual COM to the board then back to PC through standard COM is correct or not

The data can be monitored by 2 separate serial terminal programs.

Notes: *To use standard UART Port on the board, it should consider #define PORT_NUM in serial.h for the UART number will be use directly with PC.*

3. Driver Installation

"Welcome to the Found New Hardware Wizard" appears

- select '*No, not this time*'
- press 'Next'

- select '*Install from a list or specific location (Advanced)*'
- press 'Next'

- select '*Search for the best driver in these locations*'
- check '*include this location in the search*'
- set to <project folder>
- press 'Next'

Note: *The driver, lpc17x_8x-vcom.inf or lpc17xx-vcom.inf, is located in the project folder.*

"Hardware Installation Guidance" appears

- select the driver and press 'Next'

Note: *In this step, if there is any requirement about "usbser.sys", please download the file from the Ethernet.*

"Completing the Found New Hardware Wizard" appears

- press 'Finish'

4. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

5. Steps to run

1) Connect SBC1788 to a PC with a 'USB type A to Mini-B' cable through USB connector CON1. LED6 turn on.
2) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
3) Plug in +12V adaptor and power the board.
4) Rebuild the example, and then download the program into SBC1788 Flash.
5) Reset SBC1788 and run the example on the board (install driver if required).
6) Testing actions and results:
   - If UGL (USB Good Link) LED on the board is turned ON, open “Device Manager > Ports (COM & LPT)” to check for the appearance of “LPC178x USB VCOM Port (COMx)” device.

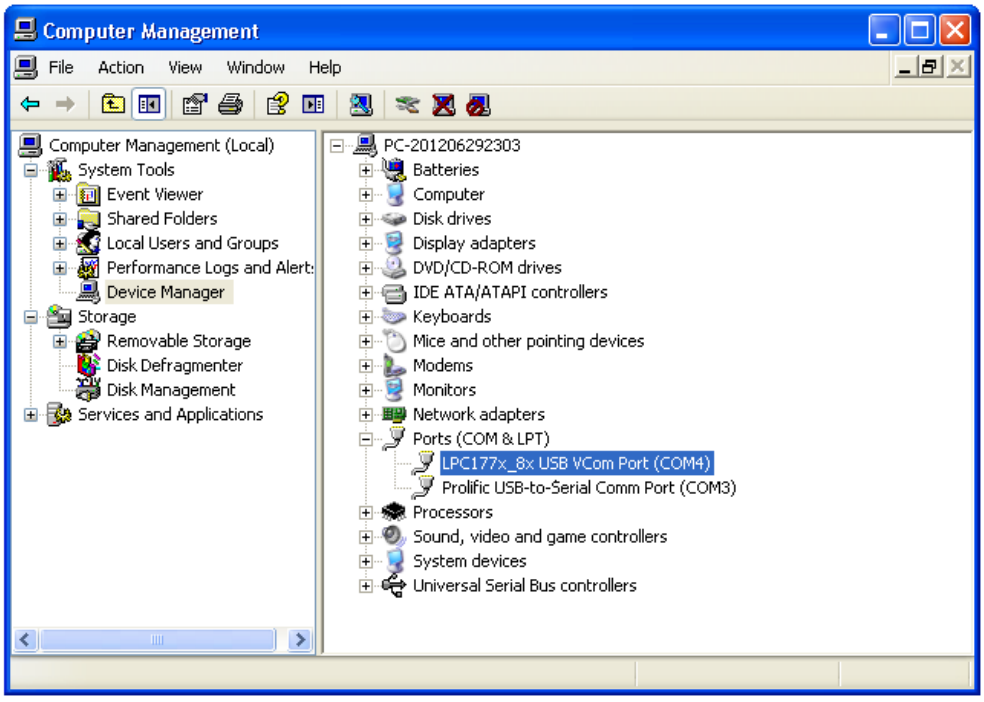


Figure 4-7 LPC178x USB VCOM Port

- Open one HyperTerminal for COM3 and other for COMx with configuration in

Section 3.3.1 HyperTerminal connection.

- Type any character on one HyperTerminal screen and see this character will be echoed in other screen and vice versa.

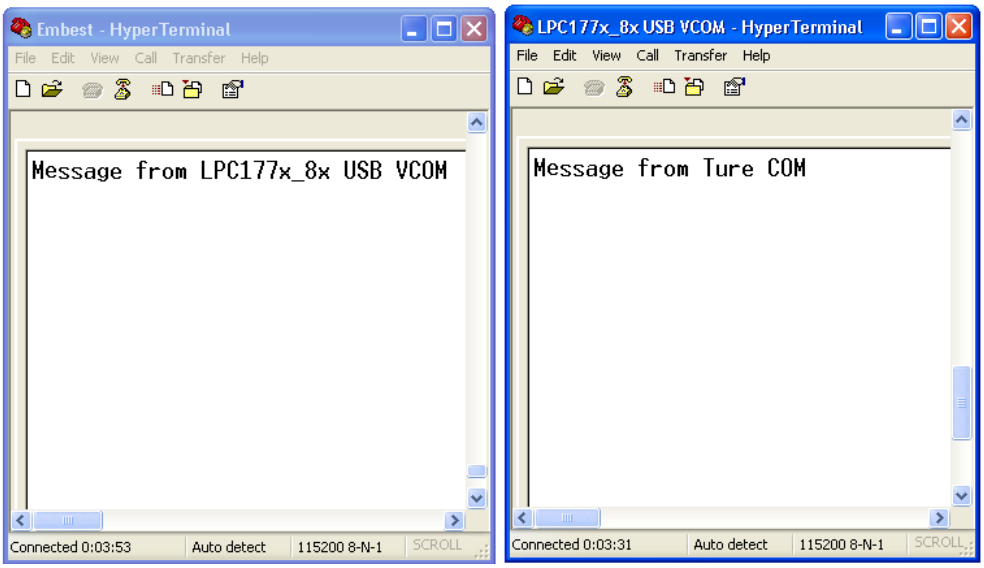

Embest - HyperTerminal
File Edit View Call Transfer Help
Message from LPC177x_8x USB VCOM
Connected 0:03:53 Auto detect 115200 8-N-1 SCROLL
LPC177x_8x USB VCOM - HyperTerminal
File Edit View Call Transfer Help
Message from Ture COM
Connected 0:03:31 Auto detect 115200 8-N-1 SCROLL

Figure 4-8 Communication between Standard COM and USB virtual COM

4.3 USBHostLite

1. Purpose

This example describes how to write a simple USB Host Controller on LPC177x_8x.

2. Description

This sample demonstrates how to access the files on "USB Flash drive" connected to USB Host port on evaluation board using NXP Semiconductors LPC177x_8x MCU.

When a USB Mass Storage device is connected, it enumerates the device, mounts the file system on "USB Flash drive" and then executes a file copy.

3. Hardware configuration

A U disk is needed in this example. Kingston 1GB/2GB or SanDisk 2GB U Disk is recommended.

4. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

5. Steps to run

1) Copy FILENAME_R.txt and Folder1 in the project folder to U Disk.
2) Insert U Disk into SBC1788 CON2.
3) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
4) Plug in +12V adaptor and power the board.
5) Rebuild the example, and then download the program into SBC1788 Flash.
6) Reset SBC1788 and run the example on the board (install driver if required).
7) Testing actions and results:
   - The content on serial terminal should be like this:

```
********************************************************************************
```

```
Hello NXP Semiconductors
UART Host Lite example
        - MCU: LPC177x_8x
        - Core: ARM CORTEX-M3
        - UART Communication: 115200 bps
This example used to test USB Host function.
********************************************************************************
Host Initialized
Connect a Mass Storage device
Mass Storage device connected
Copying file...
Copy completed
```

- Remove U disk from SBC1788 and then insert into PC. A FILENAME_W.txt is created in Folder1 and the content of the FILENAME_R.txt have been copy to FILENAME_W.txt.

4.4 Ethernet

The Ethernet folder contains three examples:

- Emac_EasyWeb
- Emac_Raw
- Emac_uIP

Emac_EasyWeb example describes how to implement an simple web application.

Emac_Raw example describes how to test EMAC driver with raw packet frame format that is not related with any upper-layer (i.e. TCP/IP...).

Emac_uIP example describes how to handle a single network interface and contains the IP, ICMP, UDP and TCP protocols.

Emac_EasyWeb

1. Description

This tiny web server was taken from the 'Design & Elektronik' extra issue 'Embedded Internet'. It can be downloaded from the following web site: www.elektroniknet.de/extraheft.

The web page shows the values of two analog inputs (AN0 and AN1).

This tiny webserver needs very little resources and therefore has some restrictions:

- only one active TCP session at any one time
- no support for fragmented IP datagrams
- no buffer for TCP datagrams received in wrong order
- only one web page. No GIF/JPG graphics possible.

The IP address can be modified in the module tcpip.h to fit into your existing LAN (see MYIP_x).

The default IP address is: 192.168.0.100

2. Hardware configuration

Try to make an external 10K, 3 pins vary-resistor, 1 terminal connects to 3.3V or

V_{REFP}, the other connects to GND, and the rest (middle pin) connects to ADC0_IN2 (P0.25, CON7.4).

3. Software configuration

HyperTerminal and Ethernet are used in this example. Please reference at 3.3.1 HyperTerminal connection and 3.3.2 PC network settings for more details.

4. Steps to run

1) Connect the external 10K, 3 pins vary-resistor following the above instructions.
2) Connect the SBC1788 to a PC with a crossover Ethernet cable through RJ45 connector CON10.
3) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
4) Plug in +12V adaptor and power the board.
5) Rebuild the example, and then download the program into SBC1788 Flash.
6) Reset SBC1788 and run the example on the board (install driver if required).
7) Testing actions and results:
   - After the evaluation board initialization, open command prompt on window PC and execute “ping 192.168.0.100” command.

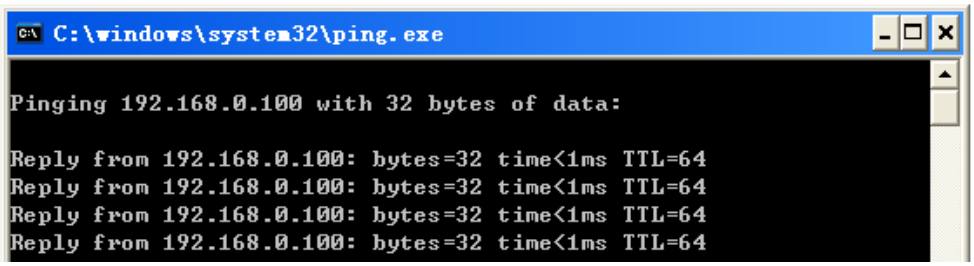

C:\windows\system32\ping.exe
Pinging 192.168.0.100 with 32 bytes of data:
Reply from 192.168.0.100: bytes=32 time<1ms TTL=64
Reply from 192.168.0.100: bytes=32 time<1ms TTL=64
Reply from 192.168.0.100: bytes=32 time<1ms TTL=64
Reply from 192.168.0.100: bytes=32 time<1ms TTL=64

Figure 4-9 ‘ping’ command

   - Open web browser, access to address "http://192.168.0.100" to display the content of webserver:

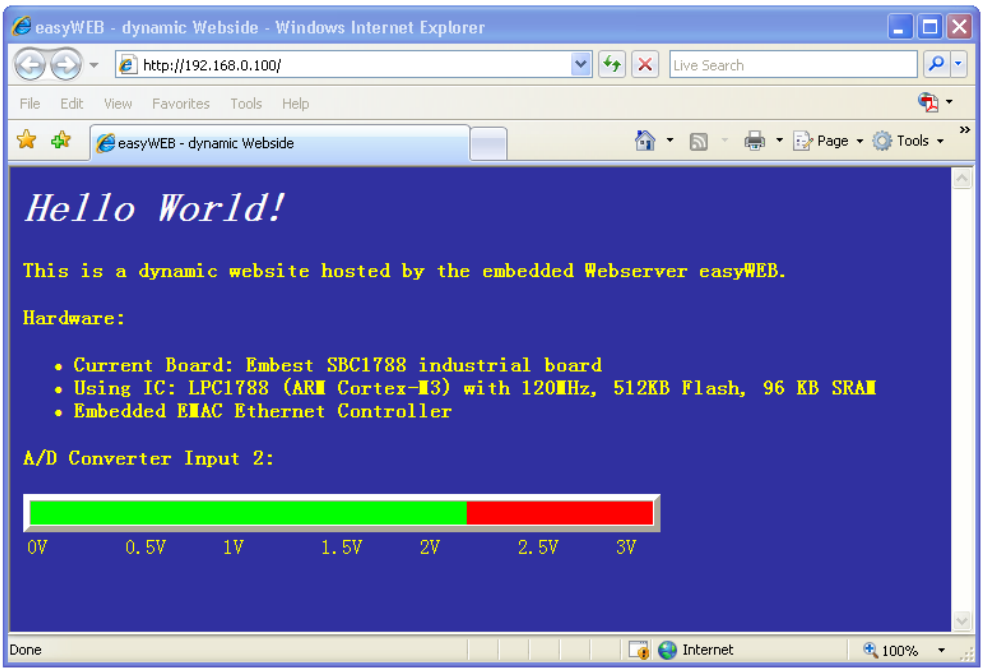

easyWEB - dynamic Webside - Windows Internet Explorer
http://192.168.0.100/
Live Search
File Edit View Favorites Tools Help
easyWEB - dynamic Webside
Page Tools
Hello World!
This is a dynamic website hosted by the embedded Webserver easyWEB.
Hardware:
• Current Board: Embest SBC1788 industrial board
• Using IC: LPC1788 (ARM Cortex-M3) with 120MHz, 512KB Flash, 96 KB SRAM
• Embedded EMAC Ethernet Controller
A/D Converter Input 2:
0V 0.5V 1V 1.5V 2V 2.5V 3V
Done
Internet
100%

Figure 4-10 The content of the Emac_EasyWeb

➢ Turn potentiometer and see the update ADC value on this web.

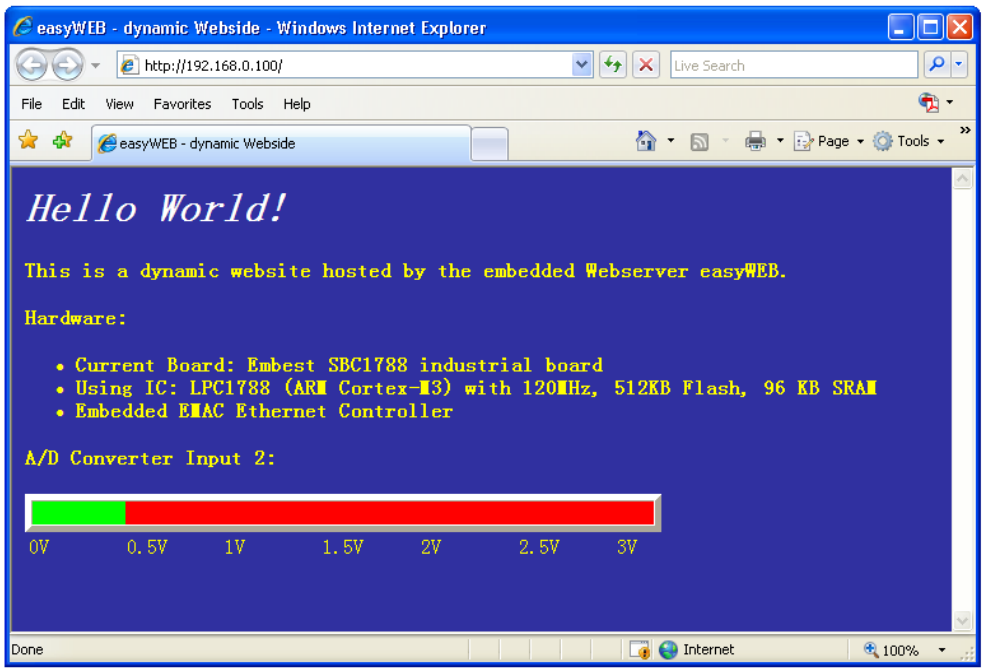

easyWEB - dynamic Webside - Windows Internet Explorer
http://192.168.0.100/
Live Search
File Edit View Favorites Tools Help
easyWEB - dynamic Webside
Page Tools
Hello World!
This is a dynamic website hosted by the embedded Webserver easyWEB.
Hardware:
• Current Board: Embest SBC1788 industrial board
• Using IC: LPC1788 (ARM Cortex-M3) with 120MHz, 512KB Flash, 96 KB SRAM
• Embedded EMAC Ethernet Controller
A/D Converter Input 2:
0V 0.5V 1V 1.5V 2V 2.5V 3V
Done
Internet
100%

Figure 4-11 The content change after turning potentiometer

4.5 UART

The UART folder contains six examples:

- UART_Autobaud
- UART_Dma
- UART_Interrupt
- UART_Polling
- Uart_Rs485Master
- Uart_Rs485Slave

UART_Autobaud example is a simple UART example using auto baudrate mode.

UART_Dma, **UART_Interrupt**, **UART_Polling** example scribes how to use UART in DMA, interrupt, polling polling mode

Uart_Rs485Master and **Uart_Rs485Slav**e example describes how to use RS485 functionality on UART2 of LPC1788 in master mode and slave mode.

4.5.1 UART_Autobaud

1. Description

UART is configured as the default settings:

- Baudrate set to auto mode
- 8 data bit
- 1 Stop bit
- None parity

After reset, firstly, type 'A' or 'a' character to start Auto baud rate mode.

Once Auto baud rate mode completed, print welcome screen, then press any key to have it read in from the terminal and returned back to the terminal.

2. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

3. Steps to run

1) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
2) Plug in +12V adaptor and power the board.
3) Rebuild the example, and then download the program into SBC1788 Flash.
4) Reset SBC1788 and run the example on the board.
5) Testing actions and results:
   - Press ‘A’ or ‘a’ character on the PC terminal to send back to the board.
   - After receiving the above character, the IC will print the welcome screen on PC terminal.
   - If typing any character on PC terminal, this character will be echo
   - The content on serial terminal should be like this:

```
AutoBaudrate Status: Synchronous!
********************************************************************************
 Hello NXP Semiconductors
 UART Auto-Baudrate example
              - MCU: LPC177x_8x
              - Core: ARM CORTEX-M3
              - UART Communication: 115200 bps
 This example used to test UART component with autobaudrate function.
 It will adjust its rate to synchronize with the sending data
   + Please press any key to be echoed
   + Press 'r' to re-show the welcome string
   + Press ESC to terminate
********************************************************************************
a Hello!Rr
********************************************************************************
 Hello NXP Semiconductors
 UART Auto-Baudrate example
```

```
            - MCU: LPC177x_8x
            - Core: ARM CORTEX-M3
            - UART Communication: 115200 bps
 This example used to test UART component with autobaudrate function.
 It will adjust its rate to synchronize with the sending data
   + Please press any key to be echoed
   + Press 'r' to re-show the welcome string
   + Press ESC to terminate
******************************************************************************
UART Auto-Baudrate demo terminated!
```

4.5.2 UART_RS485

1. Description

RS485 function on UART2 acts as Master mode on RS485 bus.

Master device will send a specified slave device address value first, then master device will send data frames. After sending completed, master device wait for response from slave device (example RS485_slave).

2. Hardware configuration

This example need two SBC1788 boards and do connection as follow:

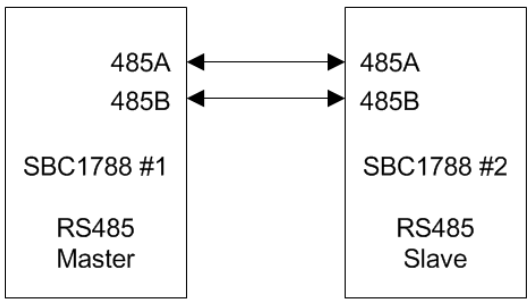


Figure 4-12 RS485 connection

3. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

Download Uart_Rs485Master program into SBC1788 #1(RS485 Master), Uart_Rs485Slave program into SBC1788 #2(RS485 Slave).

4. Steps to run

1) Connect SBC1788 #1(RS485 Master) to SBC1788 #2(RS485 Slave) through CON4 following above instructions.
2) Connect SBC1788 #1(RS485 Master) to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
3) Plug in +12V adaptor and power the two SBC1788 boards.
4) Rebuild the two examples, and then download the program into SBC1788 boards following above instructions.
5) Reset the two boards. After reset, the two boards run.
6) Testing actions and results:
   - After reset, then see the serial terminal, it should be like this:

```
Hello NXP Semiconductors
RS485 demo in Master mode
Sending to A...
Receive: ACK

Sending to B...
Receive: No Dev Reply
……
Sending to A...
Receive: ACK

Sending to B...
Receive: No Dev Reply
```

4.6 EMC

The EMC folder contains two examples:

- Emc_NandFlashDemo
- Emc_SdramDemo

Emc_NandFlashDemo example describe how to use EMC connects with On-board NAND FLASH on SBC1788.

Emc_SdramDemo example describes how to use EMC connects with On-board SDRAM on SBC1788.

4.6.1 Emc_NandFlashDemo

1. Description

NAND flash use this case is Samsung K9F1G08U0B (or K9F1G08U0D).

NAND flash memory range will be mounted at address: 0x8000 0000 - 0x800FF FFFF.

First, EMC will be initialized and set up timer compatible with this NAND flash chip.

Then check Device ID. If not correct, process will be entering into infinite loop and display error via UART.

If ID device checking is ok, entire Flash memory will be erased, 2K block data will be written and read back for verify. Verify process result will be display on terminal screen.

2. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

3. Steps to run

1) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).

2) Plug in +12V adaptor and power the board.

3) Rebuild the example, and then download the program into SBC1788 Flash.

4) Reset SBC1788 and run the example on the board.

5) Testing actions and results:

➢ After reset, then see the serial terminal, it should be like this:

```
********************************************************************************
 Hello NXP Semiconductors
 # NANDFLASH K9F1G08U0B testing
            - MCU: LPC177x_8x
            - Core: Cortex-M3
            - UART Comunication: 115200 bps
 Write and verify data with on-board NAND FLASH
********************************************************************************
Init NAND Flash...
Read NAND Flash ID:   ECF19500
Checking valid block...
Erase entire NAND Flash...
Write a block of 2K data to NAND Flash...
Read back a block of 2K data from NAND Flash...
Verify data...
Verifying complete! Testing terminated!
```

4.6.2 Emc_SdramDemo

1. Description

NOR flash use this case is 256Mbit SDRAM Micron MT48LC8M16A2P_75IT.

NOR flash memory range will be mounted at address: 0xA000 0000 - 0xAFFF FFFF.

First, EMC will be initialized and set up timer compatible with this SDRAM chip.Entire SDRAM will be cleared.

Then continue write data into SDRAM in 8-bits mode and 16-bits mode sequentially.

After each mode writing, data in sdram will be verify. If verify process fail, program will enter into infinite loop.

Please observe terminal screen for more information.

2. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

3. Steps to run

1) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
2) Plug in +12V adaptor and power the board.
3) Rebuild the example, and then download the program into SBC1788 Flash.
4) Reset SBC1788 and run the example on the board.
5) Testing actions and results:

   ➢ After reset, then see the serial terminal, it should be like this:

```
*********************************************************************************
 Hello NXP Semiconductors
 Test SDRAM mt48lc16m16A2P with LPC1788 EMC
          - MCU: LPC177x_8x
          - Core: Cortex-M3
```

```
            - UART Comunication: 115200 kbps

  Write and verify data with on-board SDRAM

********************************************************************************

Init SDRAM...

Clear content of SDRAM...

Writing in 8 bits format...

Verifying data...

Continue writing in 16 bits format...

Clear content of SRAM...

Writing in 16 bits format...

Verifying complete, testing terminated!
```

4.7 RTC

The RTC folder contains three examples:

- Rtc_Alarm
- Rtc_Calendar
- Rtc_Calibration

Rtc_Alarm example describes how to generate interrupt in Second Counter Increment Interrupt (1s) and generate Alarm interrupt at 10s.

Rtc_Calendar example describes how to configure RTC calendar.

Rtc_Calibration example describes how to calibrate real-time clock.

Rtc_Calendar

1. Description

As an application example, it demonstrates how to setup the RTC peripheral and to be used to keep time.

2. Hardware configuration

A button cell battery is needed and type model CR1220 is recommended. Install the battery into SBC1788 BAT1.

3. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

4. Steps to run

1) Install the button cell battery into SBC1788 BAT1.
2) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
3) Plug in +12V adaptor and power the board.
4) Rebuild the example, and then download the program into SBC1788 Flash.
5) Reset SBC1788 and run the example on the board.

6) Testing actions and results:

- After reset, then see the serial terminal, it should be like this:
- Restart the SBC1788 board, RTC calendar keeps the time.

```
******************************************************************************
 Hello NXP Semiconductors
 RTC Set Example:
        - MCU: LPC177x_8x
        - Core: ARM CORTEX-M3
        - UART Communication: 115200 bps
 A simple RTC Calendar example.
 To generate interrupt in Second Counter Increment Interrupt (1s)
******************************************************************************
Current time set to:
02012/003/013 016:015:030
02012/003/013 016:015:031
02012/003/013 016:015:032
02012/003/013 016:015:033
******************************************************************************
 Hello NXP Semiconductors
 RTC Set Example:
        - MCU: LPC177x_8x
        - Core: ARM CORTEX-M3
        - UART Communication: 115200 bps
 A simple RTC Calendar example.
 To generate interrupt in Second Counter Increment Interrupt (1s)
******************************************************************************
Current time is availability
02012/003/013 016:015:034
02012/003/013 016:015:035
```

```
02012/003/013 016:015:036
02012/003/013 016:015:037
02012/003/013 016:015:038
```

4.8 CAN

The CAN folder contains two examples:

- Can_Aflut
- Can_Selftest

Can_Aflut example describes how to use CAN driver functions for setup and change AFLUT table dynamically.

Can_Selftest example describes how to test CAN self-test mode.

Can_Aflut

1. Description

Using 2 pcs SBC1788 baord to test CAN operation.

This example supports all kind of identifier: FullCAN, explicit or group format.

The CANs are set baudrate at 125KHz.

First, settup AF look-up table with 5 sections:

- 6 entries for FullCAN section
- 6 entries for Standard Frame Format (SFF) section
- 6 entries for Group Standard Frame Format (SFF_GRP) section
- 6 entries for Extended Frame Format (EFF) section
- 6 entries for Group Extended Frame Format (EFF_GRP) section

Initialize 10 messages:

- 1st message with 11-bit ID which exit in AF Look-up Table in FullCAN Section
- 2nd message with 11-bit ID which not exit in AF Look-up Table
- 3th message with 11-bit ID which exit in AF Look-up Table in SFF Section
- 4th message with 11-bit ID which not exit in AF Look-up Table
- 5th message with 11-bit ID which exit in AF Look-up Table in Group SFF Section

- 6th message with 11-bit ID which not exit in AF Look-up Table
- 7th message with 29-bit ID which exit in AF Look-up Table in EFF Section
- 8th message with 29-bit ID which not exit in AF Look-up Table
- 9th message with 29-bit ID which exit in AF Look-up Table in Group of EFF Section
- 10th message with 29-bit ID which not exit in AF Look-up Table

Then, send 10 messages from CAN on the board1 to CAN on the board2, whenever receive message that has ID exit in its AFLUT, CAN receive interrupt occurs, CAN interrupt service routine "CAN_IRQHandler" will be invoked to receive message and save it in array "AFRxMsg[]".

In this case, message 1,3,5,7,9 will be received.

Re-send 10 messages and re-received messages to check if AFLUT operation correct or not.

Open serial display window to observe CAN transfer processing.

2. Hardware configuration

This example need two SBC1788 boards and do connection as follow:

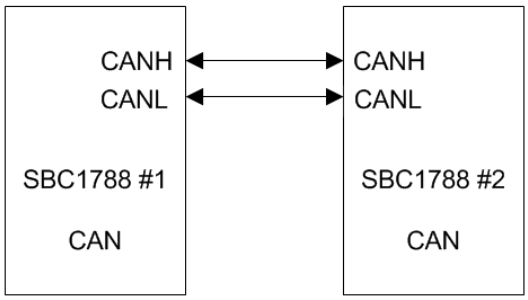


Figure 4-13 CAN connection

3. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

4. Steps to run

1) Connect SBC1788 #1 to SBC1788 #2 through CON4 following above instructions.
2) Connect either one SBC1788 board to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
3) Rebuild the example, and then download the program into the two SBC1788 boards .
4) Reset the boards. After reset, the two boards run.
5) Testing actions and results:

   After reset, then see the serial terminal, it should be like this:

```
********************************************************************************
Hello NXP Semiconductors
CAN AFLUT example:
        - MCU: LPC17xx
        - Core: ARM CORTEX-M3
        - UART Communication: 115200 bps
Use 2 CAN peripherals: CAN1&CAN2 to transfer data
This example tests full Acceptance Filter operation
and load/remove AFLUT entry dynamically functions
********************************************************************************
Test Acceptance Filter function...
Init message finished!!!
Setup AF: SUCCESSFUL!!!

Message ID:         0x00000001
Message length: 0x00000008 BYTES
Message type:      DATA FRAME
Message format: STANDARD ID FRAME FORMAT
Message dataA:    0x78787878
Message dataB:    0x21212121
```

```
Message ID:         0x00000008
Message length: 0x00000008 BYTES
Message type:      DATA FRAME
Message format: STANDARD ID FRAME FORMAT
Message dataA:    0x15151515
Message dataB:    0x36363636
……
Sending finished !!!
display received messages...


Message ID:         0x00000001
Message length: 0x00000008 BYTES
Message type:      DATA FRAME
Message format: STANDARD ID FRAME FORMAT
Message dataA:    0x78787878
Message dataB:    0x21212121
……
messages Check OK...
```

4.9 DMA

The DMA folder contains one example:

- DMA_Flash2Ram

1. Purpose

DMA_Flash2Ram example describes how to test GPDMA function by transferring data from Flash to Ram memory

2. Description

This example will transfer a block of data from Flash memory to Ram memory.

Transferred block is initialized by defining const array 'DMAScr_Buffer'. This buffer will be burned into flash when compile. Received block data is 'DMADest_Buffer' will be stored in ram when compiling.

Transfer size is 16 words.

After transferring completed, "*Buffer_Verify()*" will be called to compare data block in memory source and destination. If not similar, program will enter infinite loop.

Open serial display to see DMA transfer result.

3. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

4. Steps to run

1) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
2) Plug in +12V adaptor and power the board.
3) Rebuild the example, and then download the program into SBC1788 Flash.
4) Reset SBC1788 and run the example on the board.
5) Testing actions and results:

- After reset, then see the serial terminal, it should be like this:

```
******************************************************************************
 Hello NXP Semiconductors
 GPDMA FLASH to RAM example
          - MCU: LPC177x_8x
          - Core: ARM CORTEX-M3
          - UART Communication: 115200 bps
 This example used to test GPDMA function by transfer data from Flash
 to RAM memory
******************************************************************************
Start transfer on channel 000
Buffer Check success!
Demo terminated!
```

4.10 WDT

The WDT folder contains three examples:

- Wdt_Interrupt
- Wdt_Reset
- Wdt_WindowMode

Wdt_Interrupt example describes how to use WDT to generate interrupt after a specific time.

Wdt_Reset example describes how to use WDT to generate a reset event after a specific time.

Wdt_WindowMode example describes how to use WDT in Window Mode to generate interrupt or reset event.

Wdt_Reset

1. Description

WDT setting:

- generate reset chip when WDT times out.
- time-out = 5s
- clock source: IRC (Internal RC oscillator)

After start, WDT counter decrease until underflow (5s) to generate a chip reset.

If between 5s, RESET button is pressed, chip force an external reset.

If not, WDT will reset chip after 5s automatically.

After reset, the program will determine what cause of last reset time (external reset or WDT Timeout reset)

2. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

3. Steps to run

1) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
2) Plug in +12V adaptor and power the board.
3) Rebuild the example, and then download the program into SBC1788 Flash.
4) Reset SBC1788 and run the example on the board.
5) Testing actions and results:
   - If in between 5s, hit RESET button, after reset, we will have the notice: “Last MCU reset caused by External!”
   - Unless, WDT cause chip reset and after reset, we will have the notice: “Last MCU reset caused by WDT TimeOut!”
   - See the content on serial terminal, it should be like this:

```
********************************************************************************
This Welcome Screen below will executive after reset event
Hello NXP Semiconductors
Watch dog timer reset when timeout demo
        - MCU: LPC177x_8x
        - Core: ARM CORTEX-M3
        - UART Communication: 115200 bps
Use WDT with Internal RC OSC, reset mode, timeout = 5 seconds
To reset MCU when time out. After reset, program will determine what cause of last
reset time (external reset or WDT time-out)
The program is currently working in FLASH mode
********************************************************************************
Last MCU reset caused by External!

********************************************************************************
This Welcome Screen below will executive after reset event
```

```
Hello NXP Semiconductors
Watch dog timer reset when timeout demo
        - MCU: LPC177x_8x
        - Core: ARM CORTEX-M3
        - UART Communication: 115200 bps
Use WDT with Internal RC OSC, reset mode, timeout = 5 seconds
To reset MCU when time out. After reset, program will determine what cause of last
reset time (external reset or WDT time-out)
The program is currently working in FLASH mode
********************************************************************************
Last MCU reset caused by WDT TimeOut!
```

4.11 TIMER

The TIMER folder contains three examples:

- TIMER_Capture
- Timer_FreqMeasure
- TIMER_MatchInterrupt

TIMER_Capture example describes how to use Capture Timer function.

Timer_FreqMeasure example describes how to use Timer to measure a signal's frequency.

TIMER_MatchInterrupt example describes how to use Timer Match to generate specific time in interrupt mode.

TIMER_MatchInterrupt

1. Description

In this case, the specific time generated is 1s.

Timer configuration:

- Timer channel: 0
- Prescaler in microsecond value
- prescaler value = 100us

Match configuration:

- Use channel 0, MR0
- Match value = 10000
  - Because timer tick = prescaler = 100us
  - So match time = 100 * 10000 = 1000000us = 1s
- Timer reset after match
- Not stop MR0 when match
- Toggle MR0.0 when match
  - Because match time = 1s
  - So MAT0.0 will be toggled at frequency = 1Hz

- Generate match interrupt

Whenever MR0 matches the value in TC register, match interrupt is occurs, TIMER0 will invoke interrupt service routine to handle interrupt, in this case, it will print a notice sentence into serial display. MAT0.0 (P3.25) toggle and timer will be reseted.

Pin map:

P3.25 <---------->CON6.pin6

Note: *print data via UART can cause delay when match time set is too small.*

2. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

3. Steps to run

1) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
2) Plug in +12V adaptor and power the board.
3) Rebuild the example, and then download the program into SBC1788 Flash.
4) Reset SBC1788 and run the example on the board.
5) Testing actions and results:
   - See the wave form on the oscilloscope from pin P3.25 (CON6.6).
   - Check the below content on a PC serial terminal

```
********************************************************************************
 Hello NXP Semiconductors
 Timer Match Interrupt demo
        - MCU: LPC177x_8x
        - Core: ARM CORTEX-M3
        - UART Communication: 115200 bps
 Use timer x toggle MATx.0 at frequency 1Hz
********************************************************************************
Match interrupt occur...
```

```
Match interrupt occur...

Match interrupt occur...

Match interrupt occur...

Match interrupt occur...
```

4.12 SYSTICK

The SYSTICK folder contains three examples:

- Systick_10msBase
- Systick_Stclk

Systick_10msBase example describes how to configure System Tick timer to generate interrupt each 10ms

Systick_Stclk example describes how to configure System Tick timer use external clock source STCLK

Systick_10msBase

1. Description

In this example, System Tick timer is clocked internal by the CPU clock

In this case, CPU clock = cclk = 120MHz

System Tick timer configure:

- time interval = 10ms
- Enable System Tick interrupt

After each 10ms, System Tick will generate interrupt, interrupt service routine 'SysTick_Handler()' will be invoke and toggle P3.19 pin.

Use oscilloscope to observe signal on P3.19 and measure time between falling and rising edge, it would be: 10ms.

2. Steps to run

1) Plug in +12V adaptor and power the board.
2) Rebuild the example, and then download the program into SBC1788 Flash.
3) Reset SBC1788 and run the example on the board.
4) Testing actions and results:
   - See the wave form on the oscilloscope from pin P3.25 (CON6.6).

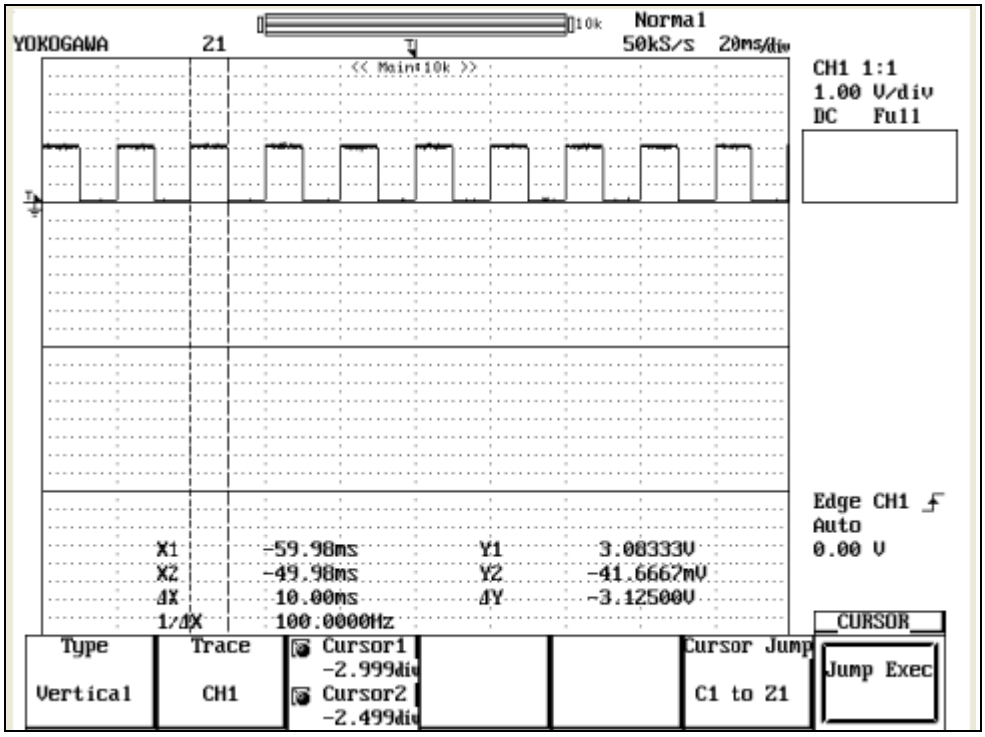


Figure 4-14 Measurement the time of the pulses

4.13 NVIC

The NVIC folder contains two examples:

- Nvic_Priorities
- Nvic_VectorTableRelocation

Nvic_Priorities example describes how to configure NVIC priority grouping for testing tail-chaining/Late-arriving interrupt mode.

Nvic_VectorTableRelocation example describes how to relocation vetor table.

Nvic_Priorities

1. Description

This example uses external interrupt 0 as IRQ channel.

Setting "*INT_MODE*" macro to choose interrupt mode test.

- INT_MODE = 0: Tail-chainning interrupt testing

  EINT0 interrupt is assigned group-priority = 0, sub-priority = 2

  ADC interrupt is assigned group-priority = 0, sub-priority = 1

  Two IRQ channels has same group. So, new ISR cannot pre-empt previous interrupt when it's executing even if new ISR has higher priority than current ISR
- INT_MODE = 1: Late-arriving interrupt testing.

  EINT0 interrupt is assigned group-priority = 0, sub-priority = 0

  ADC interrupt is assigned group-priority = 1, sub-priority = 0

  EINT0 interrupt has higher group-priority than ADC interrupt, so EINT0 interrupt can pre-empt ADC interrupt when it's executing

In this example, EINT0 interrupt occurs when pressing button SW3.

EINT0 interrupt will blink LED1 10 times.

ADC interrupt occurs period to take the ADC samples from the ADC potentiometer

ADC interrupt will blink LED2 10 times

2. Software configuration

Setting the example for expected purpose:

Testing purposes: it needs some pre-setting here in file Nvic_Priorities.c:

- If going to test TAIL CHAIN interrupt, define "#define INT_MODE 0"
- If going to test LATE – ARRIVING interrupt, define "#define INT_MODE 1".

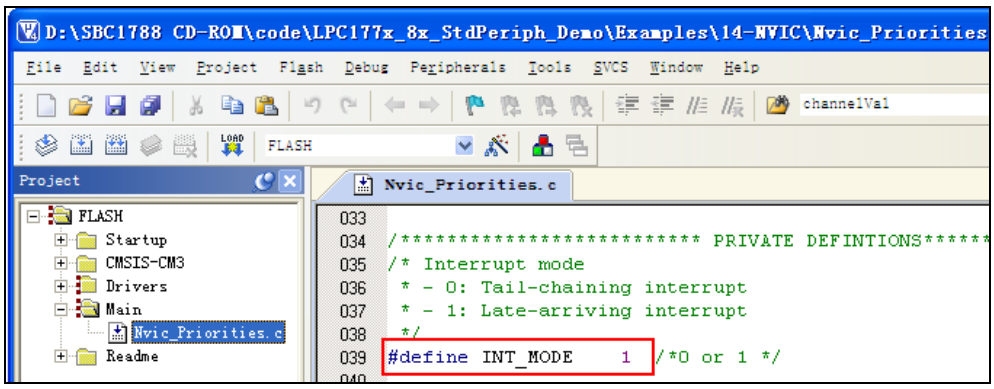


Figure 4-15 setting define for testing purposes

3. Steps to run

1) Plug in +12V adaptor and power the board.
2) Rebuild the example, and then download the program into SBC1788 Flash.
3) Reset SBC1788 and run the example on the board.
4) Testing actions and results:
   - At the beginning, the ADC interrupt will normally happen and blink LED2 in 10 times per an interrupt occurrence.
   - If EXT0 interrupt is occurred (by hitting INT0 button), LED1 will blink 10 times.
   - Depending on the test, the phenomenon will be different. It is:
     - ***Test tail-chaining interrupt mode:*** When LED2 is blinking (because of ADC interrupt), if external interrupt 0 occurs, its interrupt will blink LED1 10 times right after an ADC interrupt is finished. It means EINT0 interrupt must wait for completion of ADC interrupt in order to start itself.
     - ***Test late-arriving interrupt mode:*** When LED2 is blinking (because of ADC interrupt), if external interrupt 0 occurs, it immediately forces ADC interrupt stop to start blinking LED1 10 times. It‟s without caring about the completion of the ADC interrupt. In this case, the INT0 interrupt does

pre-empt the ADC interrupt

- After this INT0 is completed, the ADC interrupt will re-start to blink the LED2 continuously because its interrupt occurrence.

4.14 PWR

The PWR folder contains four examples:

- PWR_DeepPowerDown
- PWR_DeepSleep
- PWR_PowerDown
- PWR_Sleep

PWR_DeepPowerDown example describes how to enter system in Deep PowerDown mode and wake-up by using RTC (Real-time clock) interrupt.

PWR_DeepSleep example describes how to enter system in deep sleep mode and wake-up by using external interrupt.

PWR_PowerDown example describes how to enter system in PowerDown mode and wake-up it by using NMI (Non-Maskable Interrupt).

PWR_Sleep example describes how to enter system in Sleep mode and wake up it by using WWDT (Windowed Watchdog Timer) Interrupt.

PWR_DeepSleep

1. Description

First the program is in normal mode. And when receive '1' character from serial display, the system call 'CLKPWR_DeepSleep()' function to enter deep sleep mode. Then, when press SW3 button to to generate external interrupt, it will wake-up system and display a notice on serial display screen.

2. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

3. Steps to run

1) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
2) Plug in +12V adaptor and power the board.
3) Rebuild the example, and then download the program into SBC1788 Flash.
4) Reset SBC1788 and run the example on the board.
5) Testing actions and results:
   - Press '1' to enter deep sleep mode
   - Press SW3 button to wake up
   - See the serial terminal, it should be like this:

```
********************************************************************************
 Hello NXP Semiconductors
 Power - Deep Sleep example
            - MCU: LPC177x_8x
            - Core: ARM CORTEX-M3
            - UART Communication115200 bps
 This example used to enter system in deep sleep mode and wake up it by using
 external interrupt
********************************************************************************
Press '1' to enter system in deep sleep mode.
If you want to wake-up the system, press ISP button.
-------- I'm wake up! --------
```

4.15 GPIO

The GPIO folder contains two examples:

- GPIO_Interrupt
- GPIO_LedBlinky

GPIO_Interrupt example describes how to use GPIO interrupt function.

GPIO_LedBlinky example is used to test the functionality of key SW1,SW2 and test GPIO interrupt functionality to drive LED and Buzzer.

GPIO_LedBlinky

1. Description

After reset, the Buzzer will bells three times and LEDs will be blinking as what we set in the Gpio_LedBlinky.c.

2. Steps to run

1) Plug in +12V adaptor and power the board.
2) Rebuild the example, and then download the program into SBC1788 Flash.
3) Reset SBC1788 and run the example on the board.
4) Testing actions and results:
   - The Buzzer will bells three times then the LEDs are blinking
   - Long press on key SW1, then the blinking speed of the LEDS will be faster than what we saw at the beginning.
   - Long press on key SW2, then the blinking speed of the LEDS will be slower than what we saw on step before.

4.16 PWM

The PWM folder contains three examples:

- Pwm_DualEdge
- Pwm_MatchInterrupt
- Pwm_SingleEdge

Pwm_DualEdge example describes how to generate PWM signal on 3 Channels in both edge mode and single mode.

Pwm_MatchInterrupt example describes how to use PWM Match function in interrupt mode.

Pwm_SingleEdge example describes how to use PWM signal on 6 Channels in single edge mode.

Pwm_SingleEdge

1. Description

This program illustrates the PWM signal on 6 Channels in single edge mode

Peripheral clock for PWM: PWM_PCLK = CCLK / 2 = 120MHz/2 = 60MHz and there is no prescale for PWM.

The PWM timer/counter clock is at 60MHz. The base rate is set to 256.

The base PWM frequency is at 60MHz/256 = 234.4 KHz (Period = ~4.27 microsecond)

Each PWM channel (1 to 6) will be configured as following:

- PWMx.1 = (10/256) (period = 0.17 microsecond)
- PWMx.2 = (40/256) (period = 0.67 microsecond)
- PWMx.3 = (70/256) (period = 1.17 microsecond)
- PWMx.4 = (100/256) (period = 1.67 microsecond)
- PWMx.5 = (130/256) (period = 2.17 microsecond)
- PWMx.6 = (160/256) (period = 2.67 microsecond)

2. Steps to run

1) Plug in +12V adaptor and power the board.

2) Rebuild the example, and then download the program into SBC1788 Flash.

3) Reset SBC1788 and run the example on the board.

4) Testing actions and results:

   - Using Oscilloscope to observe the PWM1 signals

PWM1.1 (channel 1): P2.0	CON6.4
PWM1.2 (channel 2): P2.1	CON6.6
PWM1.3 (channel 3): P2.2	CON6.8
PWM1.4 (channel 4): P2.3	CON6.1
PWM1.5 (channel 5): P2.4	CON6.12
PWM1.6 (channel 6): P2.5	CON6.14

4.17 MCI

The MCI (MULTIMEDIA CARD INTERFACE) folder contains three examples:

- Mci_CidCard
- Mci_Fatfs_v008a
- Mci_ReadWrite

Mci_CidCard example describes how to use Multimedia Card Interface (MCI) on SBC1788.

Mci_Fatfs_v008a example describes how to operate on an SD card with a file system.

Mci_ReadWrite example describes how to use Multimedia Card Interface (MCI) on LPC177x_8x on reading and writing operations

Mci_Fatfs_v008a

1. Description

Plug the card to the slot, SBC1788 provides many commands for user.

They include

- commands used to operate on physical disk.
- Commands used to operate on buffer.
- Command used to operate on file system.

Commands list:

- fs --Show logical drive status
- fl --Directory listing
- fk <name> --Create a directory
- fr <name> --Read file
- fw <len> <val> --Write file

Note: *<len> means the file name which you want to write the contents into;*

<val> means the contents that you want to write into <len>.

e.g. "fw me.txt HELLOWORD! "， it will writes "HELLOWORD!" into me.txt,

it needs a space to be end after "HELLOWORD!"

- fc <src_name> <dst_name> --Copy file

  Note: *<src_name> means the source file name;*

  <dst_name> means the destination file name

2. Hardware configuration

A MicroSD card is needed in this example and *Kingston 1GB/2GB* or *SanDisk 2GB* MicroSD Card is recommended.

The card should be formatted before used.

Note: *Kingston 1GB/2GB or SanDisk 2GB MicroSD Card have been tested on SBC1788. It's not guaranteed that all kind of MicroSD card work well on the board.*

3. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

4. Steps to run

1) Insert a MicroSD card into SBC1788 card slot CON3.
2) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
3) Plug in +12V adaptor and power the board.
4) Rebuild the example, and then download the program into SBC1788 Flash.
5) Reset SBC1788 and run the example on the board.
6) Testing actions and results:

   - See the serial terminal, it should be like this:

```
>*********************************************************************************
 Hello NXP Semiconductors
 MCI File System Example
            - MCU: LPC177x_8x
            - Core: ARM CORTEX-M3
```

```
            - UART Communicationi: 115200 bps
 This example is used to demonstrate how to implement a filesystem using MCI.
 FatFs,a generic FAT file system module for small embedded systems, is used in
 ver = R0.08a
*******************************************************************************
Type the message.txt content
Hello NXP Semiconductors
MCI File System Example
Close the file
Create a new file (hello.txt)
Write a text data. (hello.txt)
14 bytes written
Close the file
read the file (hello.txt)
Type the file content(hello.txt)
Hello world!
Close the file (hello.txt)
Open root directory
Directory listing...
        65    message.txt
        14    hello.txt
Test completed
>
```

4.18 SSP

The SSP (SYNCHRONOUS SERIAL PORT) folder contains two examples:

- SSP_Dma
- SSP_LCD_Touch

SSP_Dma example describes how to use SSP peripheral with DMA support.

SSP_LCD_Touch example describes how to test touch screen use SSP peripheral.

SSP_LCD_Touch

1. Description

In this example, serial screen will display the ADC values of point that touch pen point at.

2. Hardware configuration

SBC1788 supports two kinds of LCD & Touch Screen module:

- LCD6000-43T, 4.3 inch, resolution: 480*272
- LCD6000-70T, 7 inch, resolution: 800*480

Mount LCD module onto SBC1788 CON9 through LCD cable. Red line onside indicates the first pin of LCD cable. Triangle onside indicates the first pin of LCD connector.

Note1:

- ***Make sure that LCD module mount onto SBC1788 correctly.***
- ***If 4.3 inch LCD be used, please remove C3, C5, C6 and C7 from the board. C3, C5, C6 and C7 are designed for improving EMC performance, while they may degrade touch screen performance.***

3. Software configuration

Do the change in the file lcd_driver.h according to LCD module:

- If 4.3 inch LCD module be used:

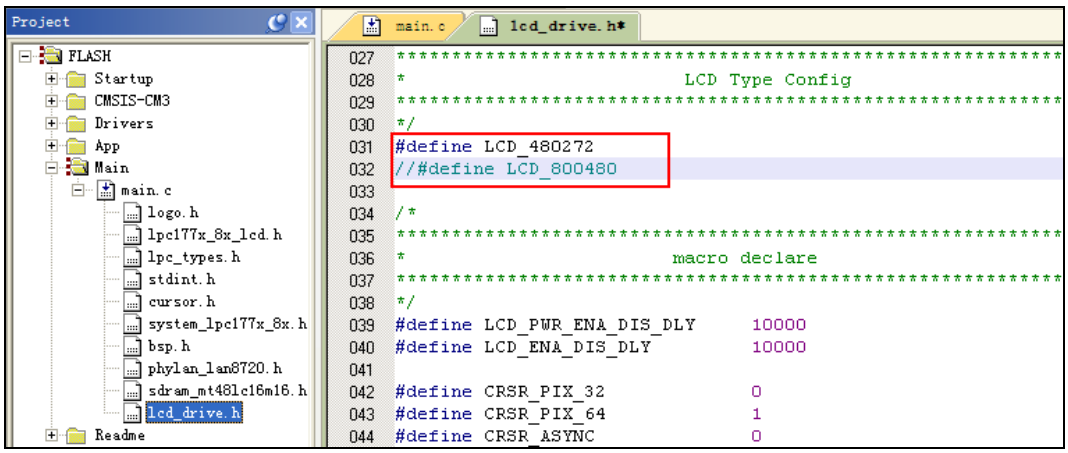


Figure 4-16 Change macro for 4.3 inch LCD module

- If 7 inch LCD module be used

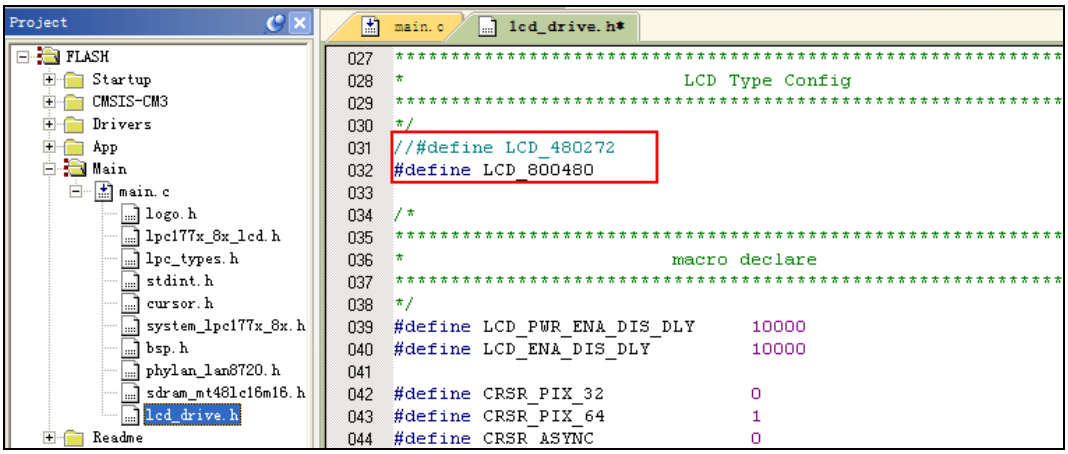


Figure 4-17 Change macro for 7 inch LCD module

4. Steps to run

1) Mount LCD module onto SBC1788 CON9 through LCD cable.

2) Plug in +12V adaptor and power the board.

3) Rebuild the example, and then download the program into SBC1788 Flash.

4) Reset SBC1788 and run the example on the board.

5) Testing actions and results:

4.19 ADC

The ADC folder contains four examples:

- ADC_Burst
- ADC_Dma
- ADC_Interrupt
- ADC_Polling

ADC_Burst example describes how to use ADC conversion in burst mode with single or multiple inputs and how to inject an ADC conversion channel while the others are running.

ADC_Dma example describes how to use ADC conversions and transfer converted data by using DMA.

ADC_Interrupt example describes how to use ADC conversion in interrupt mode.

ADC_Polling example describes how to use ADC conversion in polling mode.

ADC_Polling

1. Description

ADC is configured to convert signal on channel 2.

The ADC conversion rate is 400KHz. A fully accurate conversion requires 31 of these clocks.

So ADC clock = 400KHz * 31 = 12.4MHz.

After starting ADC operation, polling "*DONE*" bit. If "DONE" bit is set, store ADC converted data in "adc_value" and display this data via UART0 and re-start ADC for next conversion.

Turn potentiometer to change ADC signal input.

2. Hardware configuration

Try to make an external 10K, 3 pins vary-resistor, 1 terminal connects to 3.3V or V_{REFP}, the other connects to GND, and the rest (middle pin) connects to ADC0_IN2 (P0.25, CON7.4).

3. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

4. Steps to run

1) Connect the external 10K, 3 pins vary-resistor following the above instructions.
2) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
3) Plug in +12V adaptor and power the board.
4) Rebuild the example, and then download the program into SBC1788 Flash.
5) Reset SBC1788 and run the example on the board (install driver if required).
6) Testing actions and results:
   - Turn the potentiometer left or right and the content on PC serial terminal should be like this:

```
******************************************************************************
 Hello NXP Semiconductors
 ADC POLLING example:
          - MCU: LPC177x_8x
          - Core: ARM CORTEX-M3
          - Communicate via: UART0 - 115200 bps
 Use ADC with 12-bit resolution rate of 400KHz, read in POLLING mode
 To get ADC value and display via UART interface
 Turn the potentiometer to see ADC value changes
 Press q to stop the demo
******************************************************************************
ADC value on channel 002 is: 0000003889
ADC value on channel 002 is: 0000003853
ADC value on channel 002 is: 0000003640
ADC value on channel 002 is: 0000003459
```

```
ADC value on channel 002 is: 0000003270
ADC value on channel 002 is: 0000003146
ADC value on channel 002 is: 0000003002
ADC value on channel 002 is: 0000002847
ADC value on channel 002 is: 0000002730
ADC value on channel 002 is: 0000002604
ADC value on channel 002 is: 0000002594
ADC value on channel 002 is: 0000002596
ADC value on channel 002 is: 0000002611
```

4.20 DAC

The DAC folder contains two examples:

- Dac_Dma
- Dac_SineWave

Dac_Dma example describes how to use DMA to transfer data to DAC peripheral.

Dac_SineWave example describes how to use DMA to generate a sine wave signal.

Dac_SineWave

1. Description

DAC will be initialized with maximum current is 700uA. This allows a maximum update rate of 1 MHz.

Formula for output voltage on AOUT is:

$$V_{AOUT} = VALUE \times ((V_{REFP} - V_{REFN})/1024) + V_{REFN}$$

In which:

- V_{REFP}: tied to VDD(3.3V)
- V_{REFN}: tied to Vss
- VALUE: a number (in Digital form) that expected to convert to Analog form of voltage at output
- VAOUT: Analog voltage at output pin (AOUT)

DAC will generate a sine wave with peak to peak is within V_{REFP} and V_{REFN}. We need to prepare a look up table with 60 items, each item is the value to update AOUT voltage, and it's correspondent to a sample point of 1 circle sine wave signal. The formula is below:

```
for(i=0;i<NUM_SINE_SAMPLE;i++) //NUM_SINE_SAMPLE = 60
{
   dac_sine_lut[i] = 512 + 512*sin(i);
   dac_sine_lut[i] = (dac_sine_lut[i]<<6);
}
```

GPDMA channel 0 is configured in this example and used to transfer dac_sine_lut[i] to DAC peripheral.When the last item of dac_sine_lut is transfered, GPDMA will roll back to transfer the first item.

DAC is configured to use time out for each DAC value update and trigger GPDMA to fill DAC value register.

This time out value can also be used to calculate the sinewave frequency:

Time out =

*(PCLK_DAC_IN_MHZ*1000000)/ (SINE_FREQ_IN_HZ*NUM_SINE_SAMPLE);*

Where:

SINE_FREQ_IN_HZ = 60

NUM_SINE_SAMPLE = 60

Observe AOUT (P0.26) signal by oscilloscope.

2. Steps to run

1) Plug in +12V adaptor and power the board.
2) Rebuild the example, and then download the program into SBC1788 Flash.
3) Reset SBC1788 and run the example on the board (install driver if required).
4) Testing actions and results:
   - Observe AOUT (P0.26, CON7.6) signal by oscilloscope.
   - After reset, the output is in sine wave form as below:

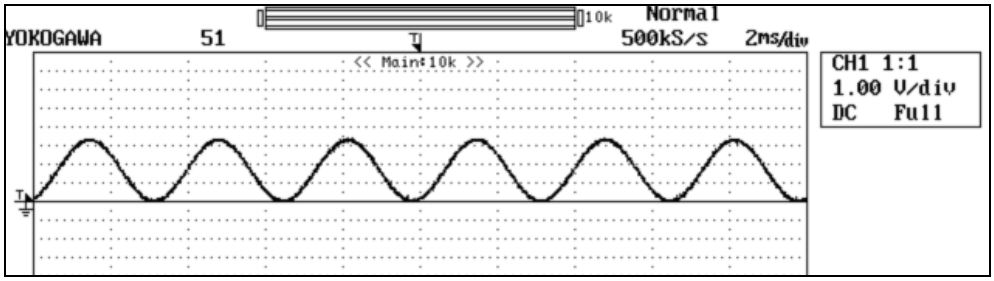


Figure 4-18 The sinewave signal from AOUT (P0.26) of DAC Sinewave example

4.21 BOD

The BOD (Brown-Out Detector) folder contains one example:

- BOD_Demo

BOD_Demo

1. Purpose

This example describes how to use BOD.

2. Description

The Brown-Out Detector (BOD) is used to monitor the voltage on VDD (REG) 3V3pins. If this voltage falls below the BOD interrupt trip level (typically 2.2 V), the BOD asserts an interrupt signal to the NVIC. When the voltage falls below the BOD reset trip level (typically 1.85 V), it asserts Reset to inactivate the LPC178x/177x.

This example uses 2 LEDS which are LED1 and LED2 on SBC1788 to notify the time that an interrupt is generated or the board is reset by BOD.

If the board is reset by BOD, the LED1 blinks. If not, LED2 are ON. When the interrupt occurs, the LED1 blinks 5 times.

3. Hardware configuration

A DC regulated power supply is needed in this example to regulate the input voltage of SBC1788.

4. Steps to run

1) Power the board with DC regulated power supply.
2) Rebuild the example, and then download the program into SBC1788 Flash.
3) Reset SBC1788 and run the example on the board (install driver if required).
4) Testing actions and results:
   - Monitor VDD3V3 by oscilloscope or multimeter.
   - Regulate the input voltage of SBC178,

- When 1.85V < **VDD3V3** <2.2V, the BOD asserts an interrupt signal to the NVIC, LED1 blink 5 times.
- When **VDD3V3** < 1.85V, it asserts Reset to inactivate the LPC178x/177x, LED1 keep blinking.

4.22 CRC

The CRC folder contains two examples:

- Crc_Demo
- Crc_Dma

Crc_Demo example describes how to use CRC engine on LPC177x_8x.

Crc_Dma example describes how to use CRC engine with DMA support.

Crc_Demo

1. Description

CRC can use one of three polynomial, include:

- CRC-CCITT
- CRC-16
- CRC-32

After initialize, CRC engine will calculate CRC-checksum for a block data with "BLOCK_SIZE" bytes and display result via UART0

2. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

3. Steps to run

1) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
2) Plug in +12V adaptor and power the board.
3) Rebuild the example, and then download the program into SBC1788 Flash.
4) Reset SBC1788 and run the example on the board (install driver if required).
5) Testing actions and results:
   - After reset, then see the serial terminal, it should be like this:

```
********************************************************************************
 Hello NXP Semiconductors
 CRC Demo example:
        - MCU: LPC177x_8x
        - Core: ARM CORTEX-M3
        - UART Communication: 115200 bps
 Use CRC engine on LPC177x_8x to calculate CRC for a 8-bit block data
 You can choose one of three polynomial type:
        - CRC-CCITT
        - CRC-16
        - CRC-32
********************************************************************************
Block data:
0x00000000    0x00000001    0x00000002    0x00000003
0x00000004    0x00000005    0x00000006    0x00000007
0x00000008    0x00000009    0x0000000A    0x0000000B
0x0000000C    0x0000000D    0x0000000E    0x0000000F
0x00000010    0x00000011    0x00000012    0x00000013
0x00000014    0x00000015    0x00000016    0x00000017
0x00000018    0x00000019    0x0000001A    0x0000001B
0x0000001C    0x0000001D    0x0000001E    0x0000001F
0x00000020    0x00000021    0x00000022    0x00000023
0x00000024    0x00000025    0x00000026    0x00000027
0x00000028    0x00000029    0x0000002A    0x0000002B
0x0000002C    0x0000002D    0x0000002E    0x0000002F
0x00000030    0x00000031    0x00000032    0x00000033
0x00000034    0x00000035    0x00000036    0x00000037
0x00000038    0x00000039    0x0000003A    0x0000003B
0x0000003C    0x0000003D    0x0000003E    0x0000003F
```

Choose what polynomial that you want to use, type:

- '1': CRC-CCITT
- '2': CRC-16
- '3': CRC-32
- 'Q': Quit

CRC-CCITT Result: 0x0000FD2F

Choose what polynomial that you want to use, type:

- '1': CRC-CCITT
- '2': CRC-16
- '3': CRC-32
- 'Q': Quit

CRC-16 Result: 0x00002799

Choose what polynomial that you want to use, type:

- '1': CRC-CCITT
- '2': CRC-16
- '3': CRC-32
- 'Q': Quit

CRC-32 Result: 0x100ECE8C

4.23 IAP

The IAP folder contains one example:

- IAP demo

1. Purpose

IAP_Demo is an example for IAP

2. Description

This sample describes how to update on-chip flash memory in the end user application code. Besides, it also read the information about the chip, including part id, boot code version and serial number, and then shows them on the terminal.

3. Software configuration

HyperTerminal is used in this example. Please reference at 3.3.1 HyperTerminal connection for more details.

4. Steps to run

1) Connect SBC1788 to PC serial port with a null-modem female/female RS232 cable through the DB9 connector COM1 (USART0).
2) Plug in +12V adaptor and power the board.
3) Rebuild the example, and then download the program into SBC1788 Flash.
4) Reset SBC1788 and run the example on the board (install driver if required).
5) Testing actions and results:

- After reset, then see the serial terminal, it should be like this:

```
********************************************************************************
 Hello NXP Semiconductors
 IAP Demotrastion
          - MCU: LPC177x_8x
          - Core: ARM CORTEX-M3
          - UART Communication: 115200 bps
```

```
********************************************************************************


PartID: 0x281D3F47

Boot Code Version: 008.001

UID: 0185272594-1397563950-1319636093-4110417927

Erase chip: Success

Program chip: Success

Demo termination
```

Charter 5 Application Demonstration

5.1 SBC1788-emWin512

1. Purpose

This example describes how to test emWin on SBC1788 single board computer.

2. Description

emWin is designed to provide an efficient, processor- and display controller-independent graphical user interface for any application that operates with a graphical display.

It is compatible with single-task and multitask environments, with a proprietary operating system or with any commercial RTOS.

It may be adapted to any size physical and virtual display with any display controller and CPU.

3. Hardware configuration

SBC1788 supports two kinds of LCD & Touch Screen module:

- LCD6000-43T, 4.3 inch, resolution: 480*272
- LCD6000-70T, 7 inch, resolution: 800*480

Mount LCD module onto SBC1788 CON9 through LCD cable. Red line onside indicates the first pin of LCD cable. Triangle onside indicates the first pin of LCD connector.

Note: Make sure that LCD module mount onto SBC1788 correctly.

4. Software configuration

The MDK project is located in following folder:

\code\SBC1788-emWin512\MDK-ARM\Start

Do the change in the file lcd_driver.h according to LCD module:

- If 4.3 inch LCD module be used:

  #define LCD_480272

- If 7 inch LCD module be used

  *#define LCD_800*480*

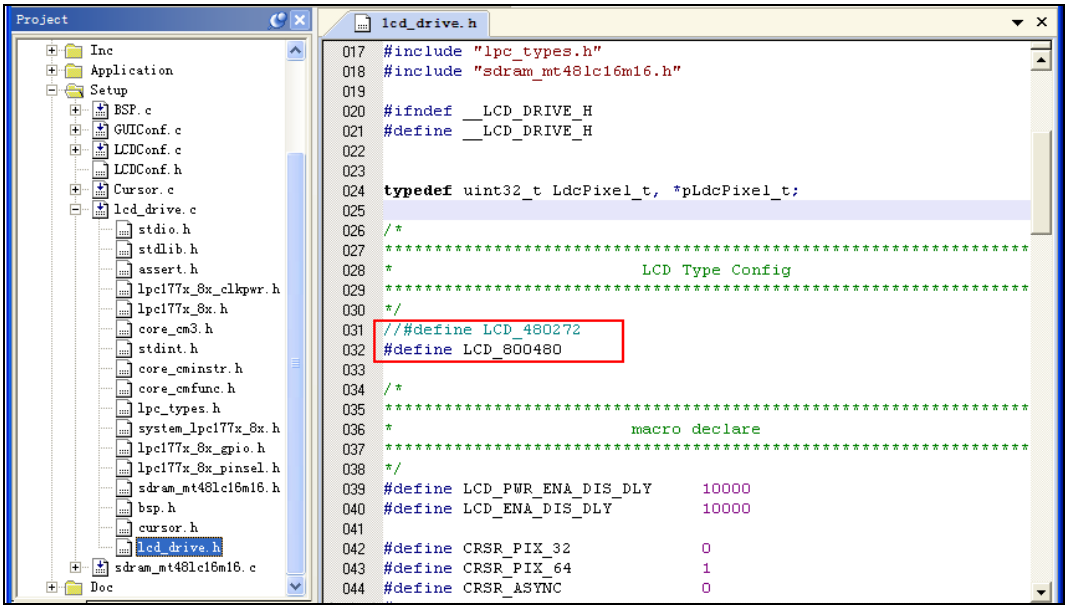


Figure 5-1 define for LCD module

5. Steps to run

1) Mount LCD module onto SBC1788 CON9 through LCD cable.
2) Plug in +12V adaptor and power the board.
3) Rebuild the example, and then download the program into SBC1788 Flash.
4) Reset SBC1788 and run the example on the board.
5) Testing actions and results:
   - LCD displays the emWin demonstration.
   - LED1 and LED3, LED2 and LED4 keep blinking

5.2 SBC1788-Lwip-v1.4.0

The SBC1788-Lwip-v1.4.0 folder contains two examples:

- httpraw_sa
- tcpecho_sa

httpraw_sa directory contains a set of sources files that implement a web server application for LPC177x_8x devices.

tcpecho_sa directory contains a set of sources files that implement a TCP echo server demonstration for LPC177x_8x devices.

5.2.1 httpraw_sa

1. Description

The MDK project of this example is located in following folder:

\code\SBC1788-Lwip-v1.4.0\lwip_lpc\nxpcommon\examples\SBC1788\httpraw_sa

2. Hardware configuration

Ethernet is used in this example. Please reference at 3.3.2 PC network settings for more details.

3. Steps to run

1) Connect the SBC1788 to a PC with a crossover Ethernet cable through RJ45 connector CON10.
2) Plug in +12V adaptor and power the board.
3) Rebuild the example, and then download the program into SBC1788 Flash.
4) Reset SBC1788 and run the example on the board (install driver if required).
5) Testing actions and results:
   - If crossover Ethernet cable good link, LED1 turn on.
   - Open command prompt on window PC and execute “ping 192.168.0.232” command.

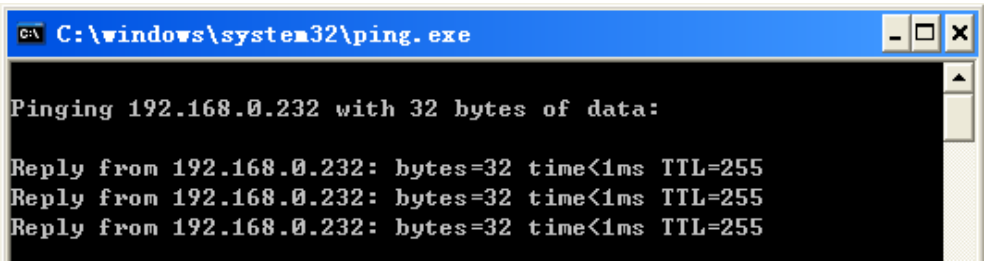

C:\windows\system32\ping.exe
Pinging 192.168.0.232 with 32 bytes of data:
Reply from 192.168.0.232: bytes=32 time<1ms TTL=255
Reply from 192.168.0.232: bytes=32 time<1ms TTL=255
Reply from 192.168.0.232: bytes=32 time<1ms TTL=255

Figure 5-2 'ping' command

- Open web browser, access to address "http://192.168.0.232" to display the content of webserver:

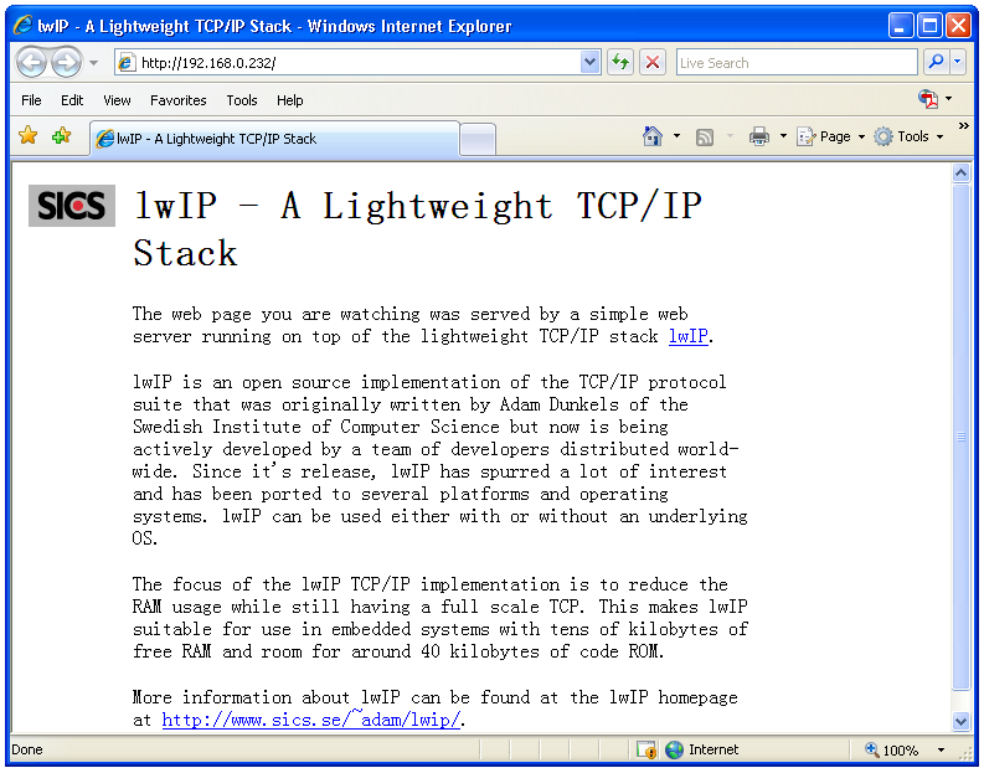

lwIP - A Lightweight TCP/IP Stack - Windows Internet Explorer
http://192.168.0.232/
File Edit View Favorites Tools Help
lwIP - A Lightweight TCP/IP Stack
SICS lwIP - A Lightweight TCP/IP Stack
The web page you are watching was served by a simple web server running on top of the lightweight TCP/IP stack lwIP.
lwIP is an open source implementation of the TCP/IP protocol suite that was originally written by Adam Dunkels of the Swedish Institute of Computer Science but now is being actively developed by a team of developers distributed world-wide. Since it's release, lwIP has spurred a lot of interest and has been ported to several platforms and operating systems. lwIP can be used either with or without an underlying OS.
The focus of the lwIP TCP/IP implementation is to reduce the RAM usage while still having a full scale TCP. This makes lwIP suitable for use in embedded systems with tens of kilobytes of free RAM and room for around 40 kilobytes of code ROM.
More information about lwIP can be found at the lwIP homepage at http://www.sics.se/~adam/lwip/.
Done
Internet
100%

Figure 5-3 LwIP httpraw_sa web page

5.2.2 tcpecho_sa

1. Description

The MDK project of this example is located in following folder:

\code\SBC1788-Lwip-v1.4.0\lwip_lpc\nxpcommon\examples\SBC1788\tcpecho_sa

2. Software configuration

Ethernet is used in this example. Please reference at 3.3.2 PC network settings for more details.

A software, echotool.exe, is needed in this example. Please copy it from *CD-ROM\code\SBC1788-Lwip-v1.4.0\Utilities\PC_Software* to your PC *C:*.

3. Steps to run

1) Connect the SBC1788 to a PC with a crossover Ethernet cable through RJ45 connector CON10.
2) Plug in +12V adaptor and power the board.
3) Rebuild the example, and then download the program into SBC1788 Flash.
4) Reset SBC1788 and run the example on the board (install driver if required).
5) Testing actions and results:
   - If crossover Ethernet cable good link, LED1 turn on.
   - Open command prompt on window PC and execute “ping 192.168.0.232” command.

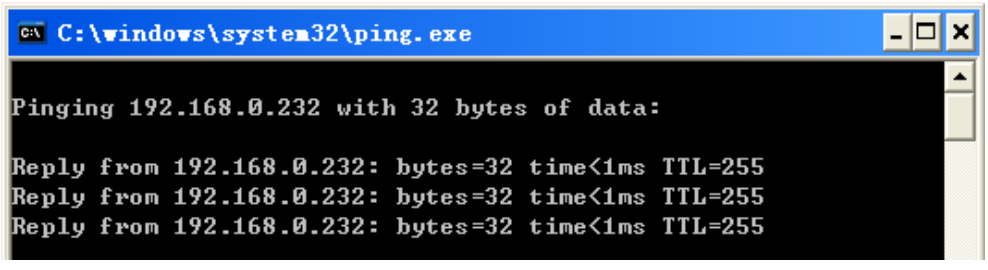

C:\windows\system32\ping.exe
Pinging 192.168.0.232 with 32 bytes of data:
Reply from 192.168.0.232: bytes=32 time<1ms TTL=255
Reply from 192.168.0.232: bytes=32 time<1ms TTL=255
Reply from 192.168.0.232: bytes=32 time<1ms TTL=255

Figure 5-4 ‘ping’ command

   - At the command prompt, enter:

C:\>echotool.exe IP_address /p tcp /r 7 /n 15 /t 2 /d Testing LwIP TCP echo

server

where;

– IP_address is the actual board's IP address;

By default the following static IP address is used: 192.168.0.232

– /p tcp is the protocol (TCP protocol)

– /r is the actual remote port on the echo server (echo port)

– /n is the number of echo requests

– /t is the connection timeout in seconds

– /d is the message to be sent for echo

- The below screenshot shows an example of this command string and the module's response.

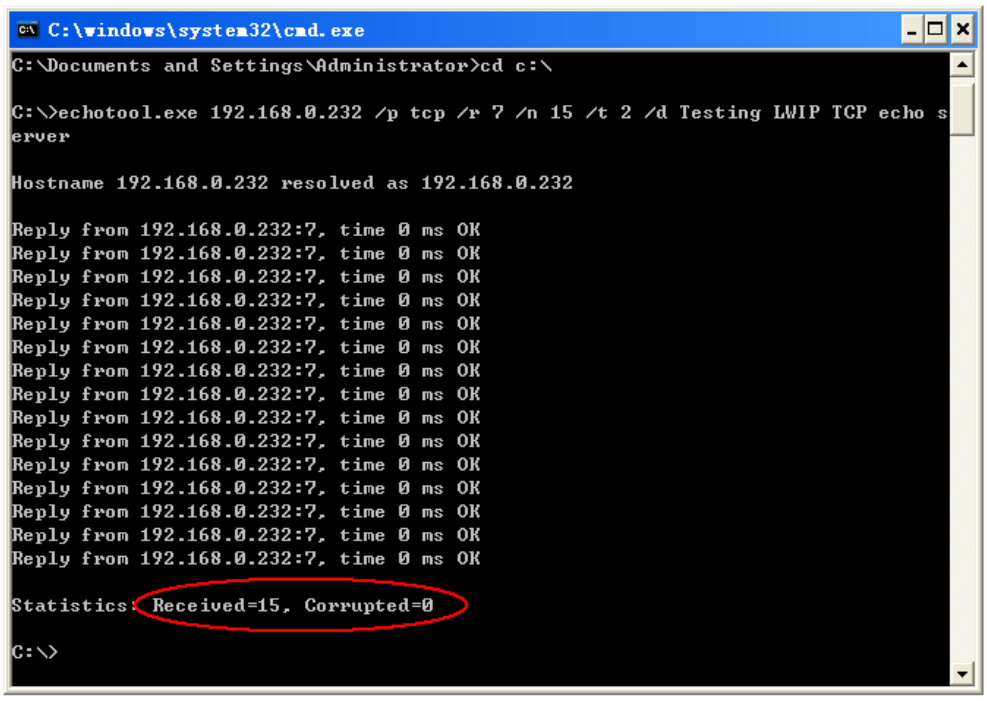

C:\windows\system32\cmd.exe
C:\Documents and Settings\Administrator>cd c:\
C:\>echotool.exe 192.168.0.232 /p tcp /r 7 /n 15 /t 2 /d Testing LWIP TCP echo server
Hostname 192.168.0.232 resolved as 192.168.0.232
Reply from 192.168.0.232:7, time 0 ms OK
Reply from 192.168.0.232:7, time 0 ms OK
Reply from 192.168.0.232:7, time 0 ms OK
Reply from 192.168.0.232:7, time 0 ms OK
Reply from 192.168.0.232:7, time 0 ms OK
Reply from 192.168.0.232:7, time 0 ms OK
Reply from 192.168.0.232:7, time 0 ms OK
Reply from 192.168.0.232:7, time 0 ms OK
Reply from 192.168.0.232:7, time 0 ms OK
Reply from 192.168.0.232:7, time 0 ms OK
Reply from 192.168.0.232:7, time 0 ms OK
Reply from 192.168.0.232:7, time 0 ms OK
Reply from 192.168.0.232:7, time 0 ms OK
Reply from 192.168.0.232:7, time 0 ms OK
Reply from 192.168.0.232:7, time 0 ms OK
Statistics: Received=15, Corrupted=0
C:\>

Figure 5-5 TCP echo server demo

5.3 SBC1788-uCOSII-uCGUI

1. Purpose

This example describes how to test uC/OS-II and uC/GUI on SBC1788 single board computer.

2. Description

The MDK project of this example is located in following folder:

\code\SBC1788-uCOSII-uCGUI\MDK-ARM

3. Hardware configuration

SBC1788 supports two kinds of LCD & Touch Screen module:

- LCD6000-43T, 4.3 inch, resolution: 480*272
- LCD6000-70T, 7 inch, resolution: 800*480

Mount LCD module onto SBC1788 CON9 through LCD cable. Red line onside indicates the first pin of LCD cable. Triangle onside indicates the first pin of LCD connector.

Note: Make sure that LCD module mount onto SBC1788 correctly.

4. Software configuration

Do the change in the file lcd_driver.h according to LCD module:

- If 4.3 inch LCD module be used:

  #define LCD_480272

- If 7 inch LCD module be used

  *#define LCD_800*480*

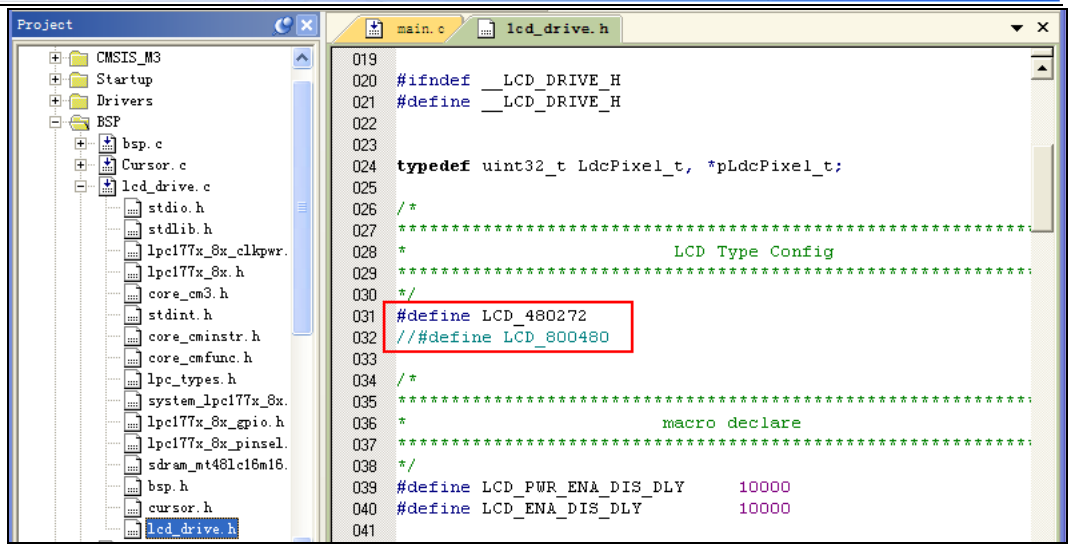


Figure 5-6 define for LCD module

5. Steps to run

1) Mount LCD module onto SBC1788 CON9 through LCD cable.

2) Plug in +12V adaptor and power the board.

3) Rebuild the example, and then download the program into SBC1788 Flash.

4) Reset SBC1788 and run the example on the board.

5) Testing actions and results:

- LCD displays the uC/OS-II and uC/GUI demonstration.
- LED1 and LED3, LED2 and LED4 keep blinking

5.4 SBC1788-uCOS-II-v2.86

1. Purpose

This example describes how to test uC/OS-II on SBC1788 single board computer.

2. Description

The MDK project of this example is located in following folder:

\code\SBC1788-uCOS-II-v2.86\MDK-ARM

3. Steps to run

1) Plug in +12V adaptor and power the board.
2) Rebuild the example, and then download the program into SBC1788 Flash.
3) Reset SBC1788 and run the example on the board.
4) Testing actions and results:
   - LED1 and LED3, LED2 and LED4 keep blinking
   - Long press on key SW1,then the blinking speed of the LEDS will be faster than what we saw at the beginning
   - Long press on key SW2,then the blinking speed of the LEDS will be lower than what we saw at the beginning

Charter 6 Various Other Tests Scenario

This charter gives a short description about how to test the SBC1788 peripheral

6.1 LCD & Touch Screen

Please reference at 4.1 LCD example.

6.2 USB Device

Please reference at 4.2 USB-Device.

6.3 USB Host

Please reference at 4.3 USBHostLite.

6.4 Ethernet

Please reference at 4.4 Ethernet.

6.5 UART

Please reference at 4.5.1 UART_Autobaud.

6.6 RS485

Please reference at 4.5.2 UART_RS485.

6.7 NAND FLASH

Please reference at 4.6.1 Emc_NandFlashDemo.

6.8 SDRAM

Please reference at 4.6.2 Emc_SdramDemo

6.9 RTC

Please reference at 4.7 RTC.

6.10 CAN

Please reference at 4.8 CAN

6.11 LED & Buzzer

Please reference at 4.15 GPIO.

6.12 MicroSD

Please reference at 4.17 MCI.

6.13 ADC

Please reference at 4.19 ADC

6.14 DAC

Please reference at 4.20 DAC

Charter 7 What's in the BOX

Order No.	T6010184	
Item	SBC1788 Single Board Computer	
Deliveries	1) One SBC1788 board 2) One 12V Power adapter 3) One cross serial cable (DB9 to DB9) 4) One cross net cable 5) One USB cable (Type A Male to Type Mini-B Male) 6) One Product CD (including user manual, schematic in PDF format, datasheet, software examples)	
Order No.	T6010184B	T6010184D
Item	SBC1788 Single Board Computer with 4.3" LCD	SBC1788 Single Board Computer with 7" LCD
Deliveries	1) One Embest SBC1788 Single Board Computer 2) One 4.3" LCD or 7" LCD (With touch screen) Remark: 4.3"LCD (resolution: 480*272), 7"LCD (resolution: 800*480)	

Technical support & Warranty Service

Embest Technology Co.,LTD., established in March of 2000, is a global provider of embedded hardware and software. Embest aims to help customers to reduce time to market with improved quality by providing the most effective total solutions for the embedded industry. In the rapidly growing market of high end embedded systems, Embest provides comprehensive services to specify develop and produce products and help customers to implement innovative technology and product features. Progressing from prototyping to the final product within a short time frame and thus shorten the time to market, and to achieve the lowest production costs possible. Embest insists on a simple business model to offer customers high-performance, low-cost products with best quality and service. The content below is the matters need attention for our products technical support and warranty service:

Technical support service

Embest provides one year free technical support service for all products. Technical support service covers:

- Embest embedded platform products software/hardware materials
- Assist customers compile and run the source code we offer.
- Solve the problems occurs on embedded software/hardware platform if users follow the instructions in the documentation we offer.
- Judge whether the product failure exists.

Special explanation, the situations listed below are not included in the range of our free technical support service, and Embest will handle the situation with discretion:

- Software/Hardware issues user meet during the self-develop process
- Issues happen when users compile/run the embedded OS which is tailored by users themselves.

- User's own applications.
- Problems happen during the modification of our software source code

Maintenance service clause

1) The products except LCD, which are not used properly, will take the warranty since the day of the sale:

   PCB: Provide 12 months free maintenance service.

2) The situations listed below are not included in the range of our free maintenance service, Embest will charge the service fees with discretion:
   a) Can't provide valid Proof-of-Purchase, the identification label is torn up or illegible, the identification label is altered or doesn't accord with the actual products;
   b) Don't follow the instruction of the manual in order to damage the product;
   c) Due to the natural disasters (unexpected matters), or natural attrition of the components, or unexpected matters leads to the defects of appearance/function;
   d) Due to the power supply, bump, leaking of the roof, pets, moist, impurities into the boards, all those reasons which lead the defects of appearance/function;
   e) User unauthorized weld or dismantle parts leads the product's bad condition, or let other people or institution which are not authorized by Embest to dismantle, repair, change the product leads the product bad connection or defects of appearance/function;
   f) User unauthorized install the software, system or incorrect configuration or computer virus leads the defects;
   g) Purchase the products through unauthorized channel;
   h) Those commitments which is committed by other institutions should be responsible by the institutions, Embest has nothing to do with that;

3) During the warranty period, the delivery fee which delivery to Embest should be covered by user, Embest will pay for the return delivery fee to users when the product is repaired. If the warranty period is expired, all the delivery fees will be charged by users.
4) When the board needs repair, please contact technical support department.

Note: *Those products are returned without the permission of our technician, we will not take any responsibility for them.*

Basic notice to protect and maintenance LCD

1) Do not use finger nails or hard sharp object to touch the surface of the LCD, otherwise user can't enjoy the above service.
2) Embest recommend user to purchase a piece of special wiper to wipe the LCD after long time use, please avoid clean the surface with fingers or hands to leave fingerprint.
3) Do not clean the surface of the screen with chemicals, otherwise user can not enjoy above service.

Note: *Embest do not supply maintenance service to LCD. We suggest the customer first check the LCD after getting the goods. In case the LCD can not run or show no display, customer should inform Embest within 7 business days from the moment of getting the goods.*

Value Added Services

We will provide following value added services:

- Provided services of driver develop based on Embest embedded platform, like serial port, USB interface devices, LCD screen.
- Provided the services of control system transplant, BSP drivers development, API software development.
- Other value added services like power adapter, LCD parts.
- Other OEM/ODM services.
- Technically training.

Please contact Embest to get technical support:

- Support Tel:+86-755-25503401
- Fax:+86-755-25616057
- Pre-Sale consultation: market@embedinfo.com
- After-Sale consultation: support@embedinfo.com